101st Congress
2d Session

COMMITTEE PRINT

S. Print
101-110

COCAINE PRODUCTION, ERADICATION, AND THE ENVIRONMENT: POLICY, IMPACT, AND OPTIONS

PROCEEDINGS OF A SEMINAR HELD BY THE CONGRESSIONAL RESEARCH SERVICE—FEBRUARY 14, 1990

PREPARED FOR THE

PERMANENT SUBCOMMITTEE ON INVESTIGATIONS

OF THE

COMMITTEE ON GOVERNMENTAL AFFAIRS
UNITED STATES SENATE

BY THE

CONGRESSIONAL RESEARCH SERVICE
LIBRARY OF CONGRESS

AUGUST 1990

Printed for the use of the Committee on Governmental Affairs

U.S. GOVERNMENT PRINTING OFFICE

32-798 ⇆ WASHINGTON : 1990

For sale by the Superintendent of Documents, Congressional Sales Office
U.S. Government Printing Office, Washington, DC 20402

S402-5

COMMITTEE ON GOVERNMENTAL AFFAIRS

JOHN GLENN, Ohio, *Chairman*

SAM NUNN, Georgia	WILLIAM V. ROTH, JR., Delaware
CARL LEVIN, Michigan	TED STEVENS, Alaska
JIM SASSER, Tennessee	WILLIAM S. COHEN, Maine
DAVID PRYOR, Arkansas	WARREN B. RUDMAN, New Hampshire
HERBERT KOHL, Wisconsin	JOHN HEINZ, Pennsylvania
JOSEPH I. LIEBERMAN, Connecticut	PETE WILSON, California
DANIEL K. AKAKA, Hawaii	

LEONARD WEISS, *Staff Director*
FRANKLIN G. POLK, *Minority Staff Director and Chief Counsel*
MICHAL SUE PROSSER, *Chief Clerk*

PERMANENT SUBCOMMITTEE ON INVESTIGATIONS

SAM NUNN, Georgia, *Chairman*
JOHN GLENN, Ohio, *Vice Chairman*

CARL LEVIN, Michigan	WILLIAM V. ROTH, JR., Delaware
JIM SASSER, Tennessee	TED STEVENS, Alaska
DAVID PRYOR, Arkansas	WILLIAM S. COHEN, Maine
HERBERT KOHL, Wisconsin	WARREN B. RUDMAN, New Hampshire
JOSEPH I. LIEBERMAN, Connecticut	PETE WILSON, California

ELEANORE HILL, *Chief Counsel*
DANIEL F. RINZEL, *Counsel to the Minority*
MARY D. ROBERTSON, *Chief Clerk*

LETTER OF SUBMITTAL

CONGRESSIONAL RESEARCH SERVICE,
THE LIBRARY OF CONGRESS,
Washington, DC, July 16, 1990.

Honorable SAM NUNN,
Chairman, Permanent Subcommittee on Investigations.

DEAR CHAIRMAN NUNN: I am pleased to transmit the edited manuscript of the CRS Seminar on "Cocaine Production, Eradication, and the Environment: Policy, Impact, and Options" held on February 14, 1990.

This seminar was designed, organized and prepared for publication by Raphael F. Perl, Specialist in International Affairs of the Foreign Affairs and National Defense Division. Terrence Lisbeth assisted in the preparation of the manuscript.

We trust this will be a timely and relevant contribution to the work of the Committee and the Congress in the formulation of national policies for the war on drugs.

Sincerely,

JOSEPH E. ROSS,
Director.

Enclosure.

Approved for printing:
Sam Nunn

FOREWORD

In 1988, the Senate Permanent Subcommittee on Investigations initiated an investigation into U.S. efforts to disrupt the activities of international narcotics trafficking in the Andean region of South America. Nature and historical accident have placed production for virtually all of the cocaine that comes to the United States in three countries of the world—Peru (approximately 60 percent), Bolivia (approximately 30 percent), and Colombia (approximately 10 percent). Although rather large in area, most of the coca leaf that is grown to produce this cocaine comes from two valleys in the Andean region—the Huallaga in Peru and the Chapare of Bolivia.

Logic and common sense tell us that stopping coca in these valleys and countries may be far cheaper and more effective than trying to do so once it arrives in the United States. There are hundreds of thousands of street corners in America where crack can be sold. But there is only one Chapare and one Huallaga. There are over 12,000 miles of U.S. coastline for the trafficker to smuggle his cocaine across, but there are only three countries where he now buys most of his coca leaf.

Aldous Huxley once said that "facts do not cease to exist simply because they are ignored." Despite the fact that almost all of our cocaine comes from these three countries, over the last ten years amazingly little attention has been paid to the region. In 1987, for example, U.S. anti-narcotics assistance for the Andes amounted to less than one percent of the amount the United States spent on all anti-drug activities. For 1989, foreign aid to all of Latin America, including the Andean region, amounted to a very small percentage of our entire foreign aid budget.

This is not to say that solutions to the cocaine problem in this region will come easily. There are many difficult policy and operational questions that must be addressed before we can possibly hope for success in this region. In the course of our Subcommittee inquiry, it became apparent that the issue of herbicidal spraying of coca in the Andean region has become one of the more serious foreign policy issues confronting our eradication policy in the Andes.

In order to more fully explore the complexities of this policy, the Subcommittee requested the Congressional Research Service to assemble a panel of experts to examine the economic, political, and environmental impact of herbicidal spraying on not only narcotics trafficking but also on the infrastructure of the countries of the Andean region.

On February 14, 1990, the panelists, including representatives from academia, government, and the Andean region, presented a broad range of views on the policy implications of using herbicidal spraying in the Andes. These proceedings highlighted many of the

central issues that will frame any future debate. The combined experiences of the panelists fairly represented the divergent views on this subject and offer both the congressional and executive branch policymaker useful insights into a controversy that had previously been mostly obscured by the emotional buzzwords of the debate.

SAM NUNN, *Chairman,*
Permanent Subcommittee on Investigations.

CONTENTS

	Page
Letter of Submittal	III
Foreword	V
Remarks of Dr. Robert Sutter, Chief, Foreign Affairs and National Defense Division, Congressional Research Service	1
PANEL I. COCA GROWING AND PROCESSING: ENVIRONMENTAL AND HEALTH CONSIDERATIONS	
Raphael F. Perl, Moderator, Specialist in International Narcotics Policy, Foreign Affairs and National Defense Division, Congressional Research Service	1
Remarks of Dr. Joseph Antognini, Research Leader, Tropical Plants Research Laboratory, USDA	3
Coca Growers Use Over a Million Kilograms of Insecticides Per Year	3
Growers Make Extensive Use of Weed Control Chemicals	4
Growers Use More Pesticides and Insecticides Yearly Than Large-Scale Eradication Would Require	4
Remarks of Dr. Marc Dourojeanni, Chief, Environmental Protection Division of Inter-American Development Bank	5
Coca Growing Is Responsible for 90 Percent of Peru's Deforestation	5
Major Environmental Impact of Coca Is Soil Loss	5
Need for Forestry Management Plans in Coca-Producing Nations	6
Remarks of Dr. Eduardo Bedoya, Anthropologist and Consultant, Upper Huallaga Coca Substitution Project	6
Coca Contributes to Deforestation	6
Coca Cultivation Is Expanding	6
Coca Growers Choose Remote Areas To Grow Crops	7
Coca Eradication Programs Aggravate Destruction of Rain Forest as Growers Seek New Fields	8
Eradication Programs Lead to Farmer Migration and Dispersal of Coca Plots	8
Rate of Coca-Related Deforestation Is Likely To Increase	8
Eradication Programs Give Platform to Sendero Luminoso	8
To Reduce Coca Production, Sendero Must Be Controlled	9
Discussion	10
Main Problem Is Economic and Political, Not Ecological	10
Chemicals Cause Damage to Waterways and Persons	11
Coca Growers Must Use Insecticides	11
Summary of Chemicals Used To Process Coca	12
Reliability of Data on Chemicals Use and Environmental Damage	13
Coca Growers Plant Additional Plots To Protect against Possible Loss of Some of Them	13
Eradication Programs Result in Reduced Size of Plots—Not Massive Migration	13
Relative Degree of Environmental Damage Potentially Caused by Eradication Compared with that Caused by Traffickers and Growers	14
Environmental Impact of Alternatives to Coca Cultivation Must Be Considered	15
Extent of Research Needed To Gather Environmentally Related Data	17
Migration to Upper Huallaga Valley Is Increasing	17
Development in Andes Requires Peace and Not Conflict with Sendero Luminoso	18

Page

PANEL II. COCA HERBICIDES: ENVIRONMENTAL AND HEALTH CONSIDERATIONS

Remarks of Raphael F. Perl, Moderator, Specialist in International Narcotics Policy, Foreign Affairs and National Defense Division, Congressional Research Service 18
Remarks of Dr. A. Lawrence Christy, National Program Leader for Weed Science, USDA 20
United States Has Two Safe and Effective Coca Herbicides 20
Tests Show Tebuthiuron Kills Coca and Not Surrounding Vegetation 21
Tebuthiuron Has Minimal Soil Persistence and Hexazinone Does Not Persist in Soil or Water 21
Remarks of Eric Rosenquist, Regional Affairs Officer, Department of State, Bureau of International Narcotics Matters 22
U.S. Regulations Require that Environmental Policy Considerations Are Applied to Overseas Activities 22
United States Has Identified Two Herbicides that Eradicate Coca with Minimal Adverse Environmental and Health Effects 23
Remarks of State Department Consultant 24
Broad Base of Data Exists for Evaluating Effects of Tebuthiuron and Hexazinone 24
Explanation of Chemical Test Evaluation Procedure 24
Spike Does Not Appear To Be Dangerous to Those Who Apply It, or to Those Who Use Cocaine Processed from Plants Killed by It 25
Under Ordinary Circumstances, Spike Poses No Adverse Human Health Effects or Problems to Aquatic Organisms 26
Remarks of Alejandro Camino, Director of Development, Peruvian Foundation for the Conservation of Nature 26
Peruvian Environmental Groups Lack Data on Use of Herbicides To Eradicate Coca 26
Data Indicates that New Coca Plantings Far Exceed Amount of Crops Eradicated 28
Most Coca Is Grown in Areas Where Forests Are Protected by Law 28
A Number of Questions Still Need To Be Addressed 28
Understanding Traditional Use of Coca Leaf in Andes Is Critical to Understanding Coca Cultivation in the Region 29
Summary of Mr. Camino's Most Important Points 29
Remarks of Stewart Hudson, Legislative Representative for International Programs, National Wildlife Federation 29
Environmental and Health Costs of Coca Production May Exceed Those of Using Tebuthiuron 29
Policymakers Must Address Whether Eradication Is Effective in Dealing with the Problem of Coca Production 30
Eradication May Be Stimulating Increased Coca Production 30
Widespread Eradication Is Not a Realistic Option 31
Demand Is Also Responsible for Spread of Coca Production 31
Option of Crop Substitution Programs Should Be Explored in Greater Detail 31
Comments by Mary E. Tiemann, Analyst in Environmental Policy, Environment and Natural Resources Policy Division, Congressional Research Service, and Panelists' Responses 32
Would Environmental and Health Damage of Eradication Be Less Than That of Coca Production and Processing 32
List of Additional Issues Which Need To Be Addressed 33
Discussion 34
Massive Eradication Might Not Be Required 34
Feasibility of Crop Substitution Programs 34
Need To Evaluate Whether Eradication Causes Farmers To Move and Plant Coca Elsewhere 35
Damage from Coca Production and Processing Compared with Damage from Spike 36
After Use of Spike, Other Crops Can Be Grown in the Soil 38
Does Environmental Community Consensus Go Beyond "Just Say 'No' To Spike" 38
Reluctance of Eli Lilly To Sell Spike for Eradication 39
Feasibility of Limiting Coca Grower Access to Pesticides 40
Biological Research on Coca Crop Control Is Being Explored 41

Page

PANEL III. ECONOMIC, POLITICAL, AND SOCIAL ISSUES AND OPTIONS FOR POLICYMAKERS

Raphael F. Perl, Moderator, Specialist in International Affairs, Foreign Affairs and National Defense Division, Congressional Research Service 41
Remarks of Eric Rosenquist, Regional Affairs Officer, Department of State, Bureau of International Narcotics Matters 41
Eradication Is Not Just an Environmental Issue 41
Eradication Is an Economic Issue 42
Most Coca Growers Are Not Trained Farmers 42
Markets for Alternative Products Are Critical 42
Lack of Public Security Challenges Viability of Crop Substitution Program 43
Demand Must Be Reduced 43
Remarks of Dr. Donor Lion, Former USAID Mission Director for Peru, Pakistan and Jamaica 44
Lack of Meaningful Economic Development Program for the Andes 44
Security Problem Must Be Solved Before Eradication and Development Can Begin 44
Need for More U.S. Resources 45
United States Needs a Regional Strategy 45
Elements of an Effective Economic Assistance and Regional Development Strategy 45
Eradication and Crop Substitution Alone Are Not Solutions 46
Eradication Does Not Cause Increases in Coca Production 46
Supply Reduction Cannot Be Neglected 47
Remarks of Dr. Elena Alvarez, Economist, State University of New York 47
Coca Plays an Important role in Andean Life 47
Need To Understand Differing Peruvian Ecological Areas 47
Reasons for Expansion of Coca Economy 48
Coca Economy Creates Political Problems for Peru 48
Peru Needs Development Assistance 48
Remarks of Peter Reuter, Co-Director, Drug Research Center, RAND Corporation 49
Eradication Programs Unlikely To Restrict Long-Term Availability of Cocaine to the United States 49
Farmers Adapt To Eradication by Dispensing and Concealing Crops 50
Eradication Can Have a Substantial Effect in Individual Source Countries, But Not on Availability of Cocaine in the United States 50
Remarks of Maureen Taft-Morales, Commentator, Analyst in Latin American Affairs, Congressional Research Service 51
Need To Support Anti-Narcotics Efforts with Economic Assistance 51
Effectiveness and Costs of Law Enforcement Strategy 51
Concern over Involvement of Andean Militaries in Counter-Narcotics Efforts 52
Funding of Counter-Narcotics Programs 52
Discussion 53
Demand Reduction Is Critical 53
Economic Assistance Must Be Linked to Eradication 53
Economic Assistance to Andean Region Unlikely to Impact on Cocaine Availability in the United States 53
Will Production Shift to Other Areas? 54
Danger that Genetic Engineering Might Be Used To Produce More Potent Coca If Eradication Makes Growing Area an Important Cost Factor 55
Drug Problem Is Regional and Cartegena Summit Should Treat It Accordingly 56
Andean Nations Need Immediate Economic Assistance and Longer Term Funding Commitments 56
Perhaps the United States and the Andean Nations Should Not Be Linked to Narcotics Preference Objectives 57
Pressure on Europeans To Provide Narcotics-Related Assistance Will Increase 57
Narcotics Problem Will Decrease for United States, But May Threaten Security of Other Nations 58
Appendix I. Needed: An Effective U.S. Anti-Drug Strategy in the Andes by Dr. Donor M. Lion 59

Page

Appendix II. Agronomics of Coca (*Erythroxylum* Species) by Dr. Joseph Antognini 65
Appendix III. Reasons for the Expansion of Coca Exports in Peru by Dr. Elena Alvarez 67
Appendix IV. The Environmental Impact of Coca Cultivation and Cocaine Production in the Peruvian Amazon Basin by Dr. Marc J. Dourojeanni 81
Appendix V. Intensification and Degradation in the Agricultural Systems of the Peruvian Upper Jungle: The Upper Huallaga Case by Eduardo Bedoya Garland 99
Appendix VI. Report of the Second Conference of Non-Governmental Environmental Organizations; Lima, Peru, July 20–22, 1989 125
Appendix VII. Victims of the Drug Trade by Professor Marcelo T. Buenaventura 143
Appendix VIII. Greenpeace Briefing Paper: State Department's Coca Eradication Spray Program in Peru 149
Appendix IX. Preliminary Draft Report: Control of Coca (*Erythroxylum* SPP.) with Herbicides in Peru by State Department Consultant 159

COCAINE PRODUCTION, ERADICATION, AND THE ENVIRONMENT: POLICY, IMPACT, AND OPTIONS

WELCOMING AND OPENING REMARKS

REMARKS OF DR. ROBERT SUTTER, CHIEF, FOREIGN AFFAIRS AND NATIONAL DEFENSE DIVISION, CONGRESSIONAL RESEARCH SERVICE

Dr. SUTTER. I'm Bob Sutter. I'm the Chief of the Foreign and National Defense Division of the Congressional Research Service and I want to particularly welcome you on behalf of Joseph Ross, the Director of the Congressional Research Service. The seminar today, of course, deals with cocaine production, cocaine eradication, and the environment—several very important issues. We're presenting today's seminar at the request of the Senate Governmental Affairs Committee's Permanent Subcommittee on Investigations. As you know, foreign policy issues relating to drugs and foreign policy issues relating to the preservation of the environment are items of major concern to many Members of the Congress. We planned today to focus on three areas: the environmental and health impact of coca growing and processing; the environmental and health impact of coca herbicides; and the economic, political, and social costs and trade-offs of policies designed to eradicate coca. The purpose of our seminar, as all CRS seminars, is to provide a diversity of viewpoints and to do so on timely and important topics on policy issues of relevance to the Congress. I think this is a very timely session and I think we can look forward to a very interesting and stimulating exchange of views. We have a fairly crowded agenda, so I want to get started right away and turn it over to our moderator this morning, Raphael Perl.

PANEL I.—COCA GROWING AND PROCESSING: ENVIRONMENTAL AND HEALTH CONSIDERATIONS

RAPHAEL F. PERL, MODERATOR, SPECIALIST IN INTERNATIONAL NARCOTICS POLICY, FOREIGN AFFAIRS AND NATIONAL DEFENSE DIVISION, CONGRESSIONAL RESEARCH SERVICE

Mr. PERL. Thank you, Bob. We do have a very distinguished panel here today and our topic this morning will be coca growing and processing, environmental and health considerations. Our first panelist today will be Dr. Joseph Antognini. Joe was a research leader in the tropical plants research lab at United States Department of Agriculture (USDA). Joe, "tropical plants"—does that mean coca plants?

Dr. ANTOGNINI. Ilicit drug plants.

Mr. PERL. Joe is by training a horticulturalist. He is an expert on weed control. He holds over 50 patents on herbicides, has over 50 professional publications in the field of herbicides, insecticides, and fungicides. He also has over 40 years experience in private industry and research and development work with chemical companies.

We are very fortunate to have as our second panelist Dr. Marc Dourojeanni. Marc is the Chief of the Environmental Protection Division of the Inter-American Development Bank. Marc is the former head of the National Agrarian University in Peru. He also is the former head of the Peruvian National Forestry Service. He is an expert on deforestation. He is an author of numerous publications, including a publication entitled "Environmental Impact of Coca Cultivation and Cocaine Production in the Peruvian Amazon Basin."

Our third panelist is Dr. Eduardo Bedoya. Eduardo is a Bolivian by nationality, but he has lived in Peru for many years, and I think you live in Peru now, is that correct Eduardo?

Dr. BEDOYA. Yes.

Mr. PERL. Eduardo is an anthropologist. He graduated from Catholic University in Peru and he is an expert on coca substitution and is a consultant to the Upper Huallaga Valley Coca Substitution Project. Eduardo is also an expert on colonization policies in the Upper Huallaga Valley and labor migration to the Upper Huallaga Valley.

Our Commentator on our First Panel today is Peter White. Peter is the Assistant Editor of *National Geographic Magazine.* Before working at *National Geographic,* he wrote for the *New York Times* magazine. He has written numerous articles, including an article in the January edition last year of *National Geographic* entitled "Coca, an Ancient Herb Turns Deadly." Peter is also an expert on Asia and has published an article for *National Geographic* on the opium poppy, so we get a broad perspective of comments and background from Peter.

Briefly, I would like to make some administrative announcements. The format for this seminar will be that each panelist will speak about five minutes, then the commentator will speak; then we'll give the panelists and the commentator an opportunity to interact with each other very briefly. We'll then go to questions, answers, and comments. We want maximum time for questions, answers, and comments. At the end of each panel session we will take a seven-minute break. I'm saying a seven-minute break because I want everybody back here within ten minutes because we have a busy agenda today. And I'd like to remind everybody that CRS policy is that our comments today are not for attribution. The Senate Permanent Subcommittee on Investigations will publish an edited version of these proceedings at a later date and the panelists will have the opportunity to edit their remarks in any fashion, shape or form that they would like. We will try to get a copy of the committee print to those of you who want it when it comes out. Without further ado, let us start. Joe.

REMARKS OF DR. JOSEPH ANTOGNINI, RESEARCH LEADER, TROPICAL PLANTS RESEARCH LABORATORY, USDA

COCA GROWERS USE OVER A MILLION KILOGRAMS OF INSECTICIDES PER YEAR

Dr. ANTOGNINI. I'm going to take my few minutes and talk about some of the pesticides that are used in the cultivation of coca amendment to Peru. This is an insect called "malunya," which is a first cousin to the gypsy moth, which most of us are familiar with. Fortunately for us here in the Northeast the gypsy moth only has one generation a year. Down there the malunya, because of the climate, has six to eight generations per year. That's the adult, this is the larvae that actually does the eating on the coca leaves, and the reason I show you that is because for the control of this insect, they are applying five to eight applications per year of insecticide and my numbers that you see here are all based on 200,000 hectares. So if you believe the hectares are greater or less you can do your own division or multiplication, but the numbers are based on 200,000 hectares. So they are using between a million six and two million six kilograms of active ingredient per year. That's not formulated product, that's active ingredient chemical to control this insect on 200,000 hectares.

Figure 1.—INSECTICIDES

— For malunya control
— 5 to 8 applications per year
— 1,686,500 to 2,698,400 KG AI*/year

* Active ingredient

QUESTION. Joe, when you say they are using it, do you mean the traffickers, the coca growers?

Dr. ANTOGNINI. The coca growers, the farmers, the growers, the producers of the leaf—this is what they are using, like our cotton growers would use parathion for insect control. These are the major insecticides that they are using. This is a carbonate. This one and this one are organophosphates and this is called a "synthetic pyrethroid" and this is roughly the percentage that they are using. There are a number of other ones used in smaller amounts. They prefer this compound, carbaryl, but if it is not available, they go to these others. The common name is "carbaryl" and the trade name is "Sevin."

Figure 2.—INSECTICIDES

— Carbaryl [1] (Sevin) [2] (70%) [3]
— Metamidophos (Monitor) (15%) [3]
— Decametrina (Decis) (10%) [3]
— Monocrotophos (Azodrin) (5%) [3]

[1] Common name
[2] Trade name
[3] Percent used of each product

GROWERS MAKE EXTENSIVE USE OF WEED CONTROL CHEMICALS

For weed control coca growers use predominantly paraquat and they treat primarily for annual weeds, which under those conditions are very prolific. The actual use rate per hectare, this is active ingredient of paraquat per hectare, five to seven applications per year, and "band" means they don't treat the solid hectare in a broadcast treatment. Coca growers will treat a band down the row representing either one-third of one-half of the total area. So if you take the lowest rate here, the least number of applications treating the least amount of area, you come up with this number here of 212,000 kg of active ingredients (AI) per year. If you go the other way and take all the higher numbers, you come out with 742,000 kg of AI per year that they are using.

GROWERS USE MORE PESTICIDES AND INSECTICIDES YEARLY THAN LARGE-SCALE ERADICATION WOULD REQUIRE

Figure 3.—PARAQUAT

— 0.53 to 1.06 KG/HA
— 5 to 7 applications per year
— BAND—1/3 to 1/2 of area treated
— 212,000 to 742,000 KG AI*/year

* Active ingredient

Jumping a bit into some of the talks later, but you need this for comparison, as you'll hear later, tebuthiuron is effective in controlling coca. The kilograms of AI of tebuthiuron that it would take to eradicate, control, kill—whatever term you want to use—the total 200,000 hectares is 672,000. If you take my highest figures and combine them for the insecticides and peraquat, you come up with 3,440,000 pounds of pesticide being used per year. So you've got two million seven kilograms more pesticide being used for controlling pests in production than you would if you wiped it all out with tebuthiuron (3,440,400 minus 672,000). If you take my lowest set of figures, you're still using 1.2 million pounds more of pesticide than you would of tebuthiuron to eradicate it. And if you want to be ultraconservative and say my numbers are totally wrong, it's only half of that, you go to the half and the number is still in favor of eradicating it because you are going to be using less total AI per year. Thank you.

Figure 4.—PESTICIDES VERSUS TEBUTHIURON (KGS)

Highest	Lowest	1/2 Lowest
[1] 3,440,400	[1] 1,898,498	[1] 949,249
[2] —672,000	[2] —672,000	[2] —672,000
[3] 2,768,400	[3] 1,226,498	[3] 277,249

[1] Insecticides and paraquat used annually.
[2] KG Tebuthiuron active ingredient to kill 200,000 HA.
[3] Net decrease in pesticide load—first year only.

REMARKS OF DR. MARC DOUROJEANNI, CHIEF, ENVIRONMENTAL PROTECTION DIVISION, INTER-AMERICAN DEVELOPMENT BANK

COCA GROWING IS RESPONSIBLE FOR 90 PERCENT OF PERU'S DEFORESTATION

Dr. DOUROJEANNI. I want to start by saying that I am not an expert in coca. I wrote, a couple of years ago, a paper on environmental impacts of coca just because I thought that it was important to demonstrate that coca and cocaine have impacts other than addiction and crime. What I did is a bibliographical review on the issue. The first environmental impact of coca plantation is deforestation. Deforestation, nevertheless, is not from my point of view its main environmental impact. If we continue assuming there are 200,000 hectares of coca in Peru, considering also that farmers cultivate 3 to 4 hectares of other crops per each hectare of coca, then we may assume that around 700,000 hectares in total were deforested directly because of coca plantation. 700,000 hectares deforested would mean a 90 percent contribution to total deforestation in Peru during the last 50 years.

MAJOR ENVIRONMENTAL IMPACT OF COCA IS SOIL LOSS

The main environmental impact of coca, however, from my point of view, is soil losses. In the paper I did I was stressing that because everyone is wanting to see water pollution and deforestation as the main issues, nevertheless, the main environmental impact of coca plantation, I insist, is soil erosion. And soil losses also mean pollution by sediments in the river system.

Soil losses are so heavy because: (1) Coca is planted in step slopes (45 percent or more). Today this problem is lesser because coca is spreading to lowlands. (2) Where coca is being planted usually you have above 2,000 millimeters of rain a year. Peasants are not applying any form of soil terracing today as in the past. Coca, historically, was cultivated in well done terraces. (3) The recollection of coca leaves is, as a matter of fact, a heavy defoliation—like in tea—and this operation is repeated three to six times a year, allowing heavy rain to directly impact on the soil. (4) There is a tradition of cleaning weeds in coca fields. In the past weed removal was done by hand, but today it is accomplished with herbicides.

It is amazing to know that, already in 1947, in the first report of the Tingo Maria Experimental Station, which was established with U.S. funding during World War II, it was pointed out that coca was the environmentally worst cultivation possible in the high jungle of Peru. So it is not a new issue. Thousands of people were killed by landslides produced by coca plantation. I assume, without doubt, that there are more people killed by landslides and violent erosion process than by all the drug wars going around in Peru.

In my paper I also mentioned river and soil pollution by utilization of pesticides and other agrochemicals, and I am not going to speak, now, about the environmental impact of production of basic paste of cocaine. I think somebody else is going to deal with these issues. I just want to end by indicating the impact of coca planting on forestry management and on conservation of genetic resources.

NEED FOR FORESTRY MANAGEMENT PLANS IN COCA-PRODUCING NATIONS

A very significant side effect of coca planting is that there is no forestry or biological conservation policy we can apply. Most national parks, national forests, other protected areas conserving the most important ecosystems of the Upper Amazon are being occupied and destroyed by coca planters. The Upper Amazon is the area of highest bio-diversity in the entire Amazon. This area is being lost because it is not possible to manage its resources. It is not even possible to have staff in these areas. This includes very important protected areas like Tingo Maria National Park, Abiseo National Park, Apurimac National Forest and others. In the paper, which I prepared in 1987, I also mentioned the problem of coca plantation spreading to lower altitude land. There, soil erosion is less serious but, as coca productivity is reduced, the area planted is larger, thus causing more deforestation. Finally, while the paper on which I am basing this summary was written more than two years ago, I believe that the current situation is following the same trends and patterns I described then. Thank you.

REMARKS OF DR. EDUARDO BEDOYA, ANTHROPOLOGIST AND CONSULTANT, UPPER HUALLAGA COCA SUBSTITUTION PROJECT

COCA CONTRIBUTES TO DEFORESTATION

Dr. BEDOYA. During the first half of the 1980s, the international demand for coca rose by nearly 50% (The InterAmerican Dialogue, 1986 Report). As a result, levels of coca production increased dramatically. This is especially apparent in the Upper Huallaga region where the amount of land devoted to coca production was conservatively estimated at 24,000 hectares in 1984 and 70,000 hectares in 1986. In other zones, increases in the rate of production have not been as great, but continue to climb steadily (ECONSULT. Evaluacion del Proyecto Especial Alto Huallaga. Lima, Peru, 1986). In 1986, coca production may have contributed to the deforestation of some 150,000 hectares.

COCA CULTIVATION IS EXPANDING

Due to the deep economic crisis that has gripped Peru since the second half of 1987—with negative indices in nearly every indicator of economic growth—coca production has expanded considerably. Even though there are no precise figures available on the amount of land currently under cultivation, which is unfortunate, Loker (Loker, William. Environment and Agriculture in the Peruvian Amazon: A Methodological Experiment. Paper presented to the Workshop "Rural Development in the Peruvian Amazon Basin". November, 1989. Lima, Peru.) estimates that the number of hectares planted in coca ranged somewhere between 100,000 and 500,000 during 1987 and 1988. In the region of San Martin, where the largest number of coca plantations and the so called Upper Huallaga Special Project are located, the figure may approach 300,000 hectares. This is five times the amount of land planted in corn, which in 1988 constituted the most important legal crop in this region (Ibid.).

In a recent article, Dourojeanni (Dourojeanni, M. Impactos Ambientales del cultivo de la coca y la produccion de cocaina en la Amazonia Peruana. Cedro. Lima, Peru, 1989. In press.) indicated that approximately 200,000 hectares in Peru are planted in coca. He notes that coca production has resulted in the deforestation of nearly 700,000 hectares since the 1970s when the number of coca producers began to increase. According to the data the author presents in a recent document, coca is responsible for 10% of the total amount of deforestation that the Peruvian Amazon has experienced this century. The figure of 700,000 hectares includes lands planted in coca, lands planted in subsistence crops to support the coca producers, lands that have been abandoned as a result of decreasing yields, and lands cleared for the construction of landing strips necessary for the transport of the coca paste. In addition, Dourojeanni notes how the growing number of coca producers has had an indirect effect on the process of deforestation by pushing legitimate agriculturalists farther and farther away from the zones of terrorism and narcotrafficking.

COCA GROWERS CHOOSE REMOTE AREAS TO GROW CROPS

Due to the illegal nature of the cultivation, two-thirds of coca producers in the Department of San Martin are settled outside the boundaries of the Special Project of the Upper Huallaga, while the remaining one-third are found inside. In both cases, they have chosen locations in remote areas far from the main highways in an effort to avoid police repression.

The agricultural production strategy followed by the colonists living within the Project area, as I've explained, involves both food production for personal consumption and market sale on the unirrigated lands, in combination with the planting of coca. In the majority of cases, the amount of land planted in coca averages 1.5 hectares (Bedoya, E. Intensificacion y Degradacion en los Sistemas Agricolas del Alto Huallaga. Serie Documentos #9. Lima, Peru, 1987). Outside of the Project area, one finds a significant sector of mono-producers who are engaged only in the production coca. The size of the coca plantations in this latter zone varies between two and three hectares. These plantations are intensively managed and utilize large amounts of modern inputs.

In the first situation, the strategy of extensive or expanded land management (though the coca plots are actually intensively managed) results in continued deforestation. In the second case, negative ecological consequences result from the large amounts of chemical compounds utilized in the production of cocaine paste (see Dourojeanni. Impactos.) as well as from the process of deforestation. The expansion of coca production in the Upper Huallaga region has produced a curious pattern in which the lands under extensive cultivation are located closer to main highways, while lots that are mono-cropped in coca and under intensive cultivation are located in more remote regions away from the Carretera Marginal and other routes of communication. This trend is the opposite of that predicted by modern theories of agricultural intensification.

COCA ERADICATION PROGRAMS AGGRAVATE DESTRUCTION OF RAIN FOREST AS GROWERS SEEK NEW FIELDS

Besides the high income derived from the cultivation of coca, another important factor that aggravates the process of destruction of the rain forest is the program of eradication aimed at reducing the amount of coca production. The eradication campaign being carried out in the Upper Huallaga region offers a clear example of the problem. In this zone, eradication has been initiated in the southern part of the valley along the eastern margin of the Huallaga region in the vicinity of Tingo Maria. When the agriculturalists learned of the program, they moved north and began clearing new fields for their coca plantations.

ERADICATION PROGRAMS LEAD TO FARMER MIGRATION AND DISPERSAL OF COCA PLOTS

As the eradication program spread north, the peasants resumed their previous migratory patterns and moved to more remote areas of the valley or to other regions such as the Central Huallaga and the Aguaytia zone of Pucallpa. This dynamic revolving around the coca eradication program and peasant migration has led to a general dispersion of coca plantations throughout the entire jungle region. This also explains why most coca producers cultivate several dispersed plots of the illegal crop. It has also contributed to the massive deforestation of areas designated as "Protected Forest" zones, or National Parks, with all the negative consequences that this entails.

RATE OF COCA-RELATED DEFORESTATION IS LIKELY TO INCREASE

It should be noted here that the Tingo Maria region of the Upper Huallaga valley is officially considered a National Park. Similarly, other National Parks, like that in Abiseo located in the Department of San Martin, and National Forests, like that of Von Humboldt located in Ucayali and Huanaco, or Biabo in San Martin and Ucayali, have also been invaded by coca-producing peasants. To the extent that the economic crisis in which Peru currently finds itself continues to worsen and the terms of exchange for legal agricultural products between city and countryside remain negative, the expansion of coca production will continue at its current rate. With respect to the problem of deforestation, it seems likely that the current annual rate of destruction will reach even higher levels and that the gravity of the ecological problem will acquire still larger dimensions.

ERADICATION PROGRAMS GIVE PLATFORM TO SENDERO LUMINOSO

However, the problem of deforestation that has been provoked by both the expansion of coca production and corresponding policies of eradication is not confined to the level of the national economic depression or to the institutional decisions related to the eradication campaign. The problem of coca and deforestation has important political dimensions as well. It is known that the political terrorist organization of Sendero Luminoso maintains a significant presence in the Upper Huallaga region. Sendero Luminoso is the only orga-

nization that openly defends the rights of the peasant coca producers, a fact that guarantees them a certain legitimacy within the region. Sendero does not limit itself to organizing and mobilizing the peasant population through the use of terrorist methods, but also encourages them to undertake continuous migrations in order to avoid the eradication program and police repression. It is precisely Sendero Luminoso that has pressured the peasant agriculturalists into relocating to the most distant and fragile zones of the Upper Huallaga.

Another aspect of the problem is the type of war that the Peruvian state has mounted against the narcotraffickers and organized terrorists. In spite of the fact that there is evidence for the existence of ties between these sectors, the government institutions have treated them as two distinct battle fronts. The government strategy has been to concentrate all of its effort for a given period on one sector while leaving the other relatively free to operate. When the government decided that Sendero was becoming too powerful in the region, it abandoned its struggle against the narcotraffickers, withdrawing DEA, UMOPAR, and the eradication program, and turned to the military suppression of the guerilla terrorists instead. This logically led to an increase in coca production in the area, given that control over the narcotraffickers had all but disappeared. In ecological terms, this signals an accelerated rate of deforestation in the region. Once it was determined that Sendero was relatively under control, the military withdrew and police forces returned anew to fight the narcotraffickers and reinstate the eradication program. But then, Sendero reorganized and again mobilized the peasant population to migrate to other regions. The deforestation resulting from the planting of new coca fields inevitably occurs again and again. It becomes clear that both government strategies of repression carry weighty ecological implications.

One final aspect in reference to Sendero and the expansion of coca plantations concerns the ideological dimension. According to our experience in the region, Sendero tries to persuade these peasants not to grow cash crops and to concentrate their agricultural efforts instead on the production of crops for family consumption. This entails a reduction in the number of coca hectares under production.

TO REDUCE COCA PRODUCTION, SENDERO MUST BE CONTROLLED

Their anti-industrial civilization, anti-market, and anti-urban ideology explains Sendero's actions with respect to the coca producers of the Huallaga region. But because the guerillas require the peasants to pay taxes, coca becomes the necessary exception to their rigid and dogmatic ideological scheme. Here again the ecological problem arises. Because Sendero promotes the development of agricultural self-sufficiency, and thus an extensive, rather than an intensive, form of agriculture, deforestation is an inevitable result. The tragedy of the Upper Huallaga is that in order to limit the amount of deforestation, it is necessary to restrict the expansion of the coca plantations, and to reduce the production of coca, one must not only resolve the national economic crisis, but also control Sendero Luminoso.

Mr. PERL. Eduardo, what do you feel are the two most important points that you have made in your presentation?

Dr. BEDOYA. Well, I think first that the eradication campaign has had important ecological consequences in terms of expanding the coca production, not only inside the Upper Huallaga area but also in all the upper jungles of Peru, and also the deforestation problem and the ecological process itself have also political dimensions because of the role of Shining Path.

DISCUSSION

MAIN PROBLEM IS ECONOMIC AND POLITICAL, NOT ECOLOGICAL

Mr. WHITE. Interesting to hear from Dr. Antognini that such large quantities of insecticides are being used that even if all eradication were to be done by insecticides there would not be that much more environmental damage. It's interesting to hear from Mr. Dourojeanni that soil loss is the main problem there. But I would suggest that all those basic figures on how much coca grows, and how much cocaine is produced, are very, very questionable. By the way, the coca plant has enormously deep roots. You don't plant it once as in the case of the opium poppy. A coca plant produces for dozens of years and it is very hard to uproot after three years. If you cut it, and you don't cut it terribly close—if it is just two inches above the ground—it will sprout again. That is a great problem, but the main problem, I would suggest, is not a botanical matter. The main problem is, as in so much else—and I'm sure people on the Hill know this very well—is first of all economic, but above all political. Eradication by herbicides is politically almost impossible. In Peru they'll say, "Yes, yes, we'll try it, we'll make experiments." But it's just not ever done. The second problem, which again is known to our government people who spend much time there, is that while our money is gratefully accepted, what is actually done in the way of eradication, of suppression, is really very little. We speak about the Huallaga Valley. Policemen ask to be assigned there, they'll pay money for it, because this is an extremely lucrative place for policemen. This sounds snide for an outsider to say, but I ask, is this not the truth? Ask our people stationed down there. They know it, but what shall they say—that all this is useless? That we should stop it? One cannot go and report that. What kind of reception would it get? And so we go on saying we must try to improve things. Maybe in Bolivia the minister in charge of this was bad, he was connected with the traffickers, but the present one is not as bad, we hope. Then after he is gone, you find that the one who is now the previous one was terrible too, but we hope for a better one now. All this is known back here, but really to do something effective seems almost impossible. Does that mean that there is not hope at all? No, there will be hope when the demand here drops and there is no market for this crop. Or when the price paid for coca leaf will drop so low that people will not want to grow it anymore.

Mr. PERL. Thank you, Peter. Would any of the other panelists like to make a comment before we open up the floor for questions, answers, and comments?

CHEMICALS CAUSE DAMAGE TO WATERWAYS AND PERSONS

QUESTION. I'd like to just pose a question to the panel, particularly Dr. Antognini. You discussed a number of the chemicals that are being used. What are the health impacts? Do we have data on the use of any of those chemicals you listed, in whatever dosage?

Dr. ANTOGNINI. Those are insecticides. The data are available in handbooks and so forth. I might just give you one number, and these are published EPA health advisories and drinking water, for example. For carbaryl, the health advisory level is 700 milligrams per liter. You compare it to tebuthiuron which is 500. They are in the same ball park. You can look at—I don't have it for all the others—but there is a lot of published data that are available in the literature about the acute toxicity, fish toxicity, etc. of all of these chemicals.

QUESTION. Have there been any studies done in the Upper Huallaga Valley about the run-off into the streams? What is the water like down there? Has anybody done that?

Dr. DOUROJEANNI. No, I am sure not. But the main problem for human population is not coming from agro-chemicals but from the chemicals utilized in the preparation of the basic paste of cocaine (BPC). Anyhow, fisheries and all forms of life are almost totally destroyed in the small streams. In the very large Huallaga River, its capacity of dilution is enormous and, therefore, risks for human life are reduced.

Dr. BEDOYA. There is a researcher in Bolivia named Jos Blanes who has done several studies about the Chapare area. He talks about peasants who have burned hands and burned feet because of the amount of chemicals used in the transformation from coca leaves to cocaine base. But also he talks about genetic transformations among these populations. I haven't really investigated much of these.

COCA GROWERS MUST USE INSECTICIDES

QUESTION. I'd like to make two brief comments. One of the characteristics as I understand of coca is that you get entire yields if you use insecticides. You don't need insecticides to grow coca. Your yields are much higher with insecticides. The significance is that poor farmers who may not be able to afford insecticides or are not given insecticides by the traffickers can still grow coca without modern inputs.

Also, Mr. White suggested that the basic reasons why herbicides were not used, or rather were opposed in Peru, was political. My own guess is that the basic reason is economic because the government and other authorities are afraid that the use of herbicides will succeed in eradicating coca and that is the situation that cannot stand at this point without any alternatives to coca.

Dr. ANTOGNINI. May I make a comment regarding the insecticides? In many areas if they don't spray for malunya, it's not a reduced yield, it is no yield, period. It is wiped out, hectares, thousands of hectares if you don't control it; it moves worse than a gypsy moth does. And as far as being able to buy insecticides, all the information that I know of is that the producers (the growers of coca) are paying four, five and six times the going price for the

insecticides so the legitimate grower of corn, or whatever it may be, can't even buy these insecticides because they are paying whatever black market price they have to pay to get them because if they don't, they're not going to harvest a coca leaf crop.

SUMMARY OF CHEMICALS USED TO PROCESS COCA

QUESTION. Could someone give us a summary of the amounts of chemicals being used and of the initial processing form?

RESPONSE. That will be the matter of the next panel, I understand.

Mr. PERL. The next panel will address coca herbicides. This is on coca production, coca growing and processing. Marc, would you be able to do that, or Eduardo?

Dr. ANTOGNINI. Mr. Chairman, if I may. I have two slides based on Marc's data that he has published on, to answer this question.

Dr. DOUROJEANNI. The main problem related to the application of agro-chemicals in coca, especially pesticides, may be for the consumers of Basic Paste of Cocaine (BPC).

Dr. ANTOGNINI. All these extraction chemicals by our U.S. EPA and Resource Conservation Recovery Act (RCRA) are classified as hazardous waste.

Figure 5a.—EXTRACTION CHEMICALS

U.S. Environmental Protection Agency (EPA)
Resource Conservation Recovery Act (RCRA)

All classified as hazardous waste by above two agencies.

Figure 5b.—EXTRACTION CHEMICALS *

Kerosene	57,954,000 KG
Sulphuric Acid	30,909,000 KG
Acetone	6,181,000 KG
Touluene	6,181,000 KG
Lime	14,545,000 KG
Carbine	2,909,000 KG
	119,679,000 KG

* Used to process coca in 1987.

This whole list of chemicals that you have seen published by Marc and others that are used are all classified by our EPA as hazardous waste. To take the main ones, and these are 1987 figures, so whatever those hectares were and whatever you want to do for 1989 or 1990 these are the kilograms that are being used of these extraction chemicals and these are the sums that the gentleman is referring to where they have burned hands and burned feet. How would you like to wade around and handle these all day without the necessary precautions of handling hazardous waste? But look at the number, 119 million kg per year and this again is an environmental question of what's it do to the environment. The

streams are dead biologically from this. These things are extremely hazardous. They change the pH of water. Fish die immediately when you drop the pH when you're looking at something like sulfuric acid.

Dr. DOUROJEANNI. Just an alert about these dates, which you have also in my paper: This was a compilation made by one of my students with very little time and not scientifically collected data. In fact, this paper was done to sustain a research project, to make a good study on environmental impacts of coca and cocaine, but it was never funded.

RELIABILITY OF DATA ON CHEMICAL USE AND ENVIRONMENTAL DAMAGE

Mr. PERL. One of the things that strikes me is just the lack of data on this area. Aren't the governments concerned about it and funding studies to gather information, or is it just that their priorities are so different?

Dr. DOUROJEANNI. The government of Peru has no money for anything. So it is indeed out of order to ask them to do research. This project was solicited by an American institution which, later on, decided not to fund the project.

Dr. ANTOGNINI. But you can come up with these numbers by back-calculating whatever numbers you want to use of total pounds of coke and just back-calculating what it takes to process, and then these numbers are not that far off if you back-calculate.

Mr. WHITE. If you try to go in and count—and you'd have to count from the ground, really not from above—you'll get killed. That partly explains why the data . . .

Dr. DOUROJEANNI. It is relatively easy to count the deforested area from remote sensing. Such an information certainly does exist. It is somewhere.

COCA GROWERS PLANT ADDITIONAL PLOTS TO PROTECT AGAINST POSSIBLE LOSS OF SOME OF THEM

Dr. BEDOYA. From data that I gathered between 1983 and 1987 I made a survey about coca products. In 1987, the majority of them had two to three plots of agricultural products, basically coca. In 1983 I remember that most coca farmers had an average of only one plot of coca. They now have coca plots in the southern part of the valley and in the eastern part of the valley and the northern part of the valley in order to be secure that if they lose some of these plots they will at least have one. That is a social strategy to keep their coca plantations.

ERADICATION PROGRAMS RESULT IN REDUCED SIZE OF PLOTS—NOT MASSIVE MIGRATION

Mr. ROSENQUIST. Historically, the State Department supported opium and cannabis eradication projects. There are no examples where we have had a viable eradication program for coca, so, consequently, there are no historical examples of where massive eradication programs a have pushed people back into the jungle for the purpose of coca eradication. In the case of marijuana there are a number of examples, e.g., in Belize, where we have had experience

for several years in the eradication of the marijuana plantations. And the evidence is that, yes, people go back to some extent, but ultimately they break up the size of the plots, rendering them smaller and less economical as they move back farther into the marginal lands. Their overall efficiency declines very rapidly, e.g., as in Jamaica, and smaller amounts of hectare areas are cultivated. The net effect is substantially less cultivation and production. I would hesitate to use the word "eradication." Eradication of illicit crops is not technically feasible. If you talk about controlling illicit production through chemical agents, it certainly is a viable strategy. In the case of coca, speaking in the theoretical sense, chemical control is safe and feasible. The growers will experience a very rapid economic loss, which will take years to recoup, so there is a strong possibility that some won't move back to increasingly marginal lands in order to reestablish their crops, for which the price is actually very low. So it is unlikely that if you did have a full-scale eradication program that the destroyed crop will be totally replaced.

RELATIVE DEGREE OF ENVIRONMENTAL DAMAGE POTENTIALLY CAUSED BY ERADICATION COMPARED WITH THAT CAUSED BY TRAFFICKERS AND GROWERS

QUESTION. Let me pose just one simple question. Maybe it's the ultimate question to every member of the panel, and that is environmentally speaking, not politically, not economically, not religiously, or any other reason, just environmentally speaking, is it more of an environmental damage to eradicate the crops than to continue currently with the dumping of the chemicals and all that? Dr. Dourojeanni, I think you were sort of answering that question before, but if I could pose that just to each member of the panel, from the environment.

Dr. ANTOGNINI. Environmentally, we are far better off to eradicate it with an herbicide than continue with those numbers you saw.

Mr. PERL. Would that be a one-shot deal primarily, do you think?

Dr. ANTOGNINI. It gets back to what Mr. Rosenquist said because if you eradicated it all with an herbicide, and it depends which one, that they could go back and replant that crop, and they are going to find this out in a hurry, and probably somewhere between three and six months they could plant it back. But then, as you said, it takes another 18 months or so before you harvest. So from the time of the treatment till they would get another crop is two years. So you may have to go back a second time, then you break the cycle. That's up for grabs as to whether you would have to treat once or twice or whatever.

Dr. DOUROJEANNI. I think it is important to make a comment to your comment. I agree with you in many aspects, but there are two more aspects to consider. First, it is a fact that coca is spreading into lowlands. That means that more people are entering into the Amazon and are starting to work coca. I believe there is also an impact of intent of eradication, pushing the coca farmers and other farmers to safer places. The coca being planted in the lower land produces less as a consequence of site ecology and also because its

being planted below tree shade, to avoid aerial detection. Therefore, the extension being cultivated is larger to be able to have the same amount of coca produced. That's also to be considered. To answer your question, sir, if eradication is viable in social and economic terms, I would be fully for it. But, frankly, I think it is impossible. So, in this case, other options are necessary.

Dr. BEDOYA. I agree in general terms with Marc. The only thing that I would say, it's really difficult to isolate the environmental factors from the social and political factors. It's a reality. I have seen many capable American professionals go the area of the Upper Huallaga and design a technological and agricultural system suitable for the area of Upper Huallaga. But I have told them that this area was in such social convulsion that it is really impossible to apply all this technology in the area.

Mr. PERL. Eduardo, we're not going to let you get away this easily. It was an important point that you made, but John asked you a very specific question. Not social and political, environmental—more damage to the ecology from the traffickers and production or more damage from eradication?

Dr. BEDOYA. I think more damage comes from the traffickers, obviously, and the chemical compounds.

Mr. WHITE. May I say something here, and again this sounds a bit harsh. Interest in the environment in the countries that we are talking about exists among the few people there, often encouraged by outsiders, people from here. You see articles in newspapers, you see surveys, but generally speaking, there is not much interest. In Colombia El Tiempo will write about the damage done by the chemicals, but do a lot of people in Colombia really care? Even though there is in fact a rising coca smoking problem. The surveys are made by American agencies, and we like to encourage talk about it, but I think environmentalism at this point, politically, does not seem to be a significant factor in Colombia, in Bolivia, or in Peru, and I ask if I am wrong about this.

Dr. DOUROJEANNI. Your final conclusion is correct. If any government in the region is presented the option to eradicate coca because of the environment, they will say no, of course.

ENVIRONMENTAL IMPACT OF ALTERNATIVES TOCOCA CULTIVATION MUST BE CONSIDERED

QUESTION. Even speaking strictly in environmental terms, I don't see how we can make the cost/benefit analysis without also considering alternative activities that are going to take place there to replace coca cultivation. And it seems to me that until one does that, that it's considered unuseful to try to draw a calculation between chemicals used for eradication and chemicals used for coca growing and alternatives. Can any of the panelists address the hypothetical environmental impacts of alternative activities? Has that been discussed?

Mr. PERL. And also, how much of this land would be suitable for traditional farming? It looks to me as though a lot of this is just suitable for a natural park. This is part of the rain forest. You have a hilltop somewhere in the middle of nowhere and someone

has cut down the trees and is planting coca and that it should be rain forest and not agricultural land.

Dr. DOUROJEANNI. Coca needs soils with good drainage, and that is why coca was traditionally always planted in slopes. The spread of the coca was initially from the mid-slopes of the valley to the upper slopes and, today, also to lowlands, spreading the problem.

Mr. PERL. I don't want to detract from the question that was asked about alternative development.

Dr. DOUROJEANNI. But there are many alternative developments that are viable. Eradication, in the isolation as it was discussed, is just impossible. There are answers to the problem, certainly, but they will require a worldwide input. I think that world security is at stake. This is a matter of much larger magnitudes and larger solutions than to deal only with the coca plants themselves or with the drug traffickers. Development is the best answer.

Mr. WHITE. But the main question, again, is for substitute crops. Yes, they can be grown, but is there a market for them?

COMMENT. The environmental impact. It seems to me what you then have to do in sort of making the cost/benefit assessment is look at environmental impact of eradication plus alternative activities. I understand that, but that of course is optimistic.

Dr. ANTOGNINI. But your question comes from a real misconception that was mentioned here. There was nothing grown on those mountaintops before. Everybody thinks that these people were growing corn and yucca bananas and everything before. They were not, they stripped the forest and planted coca and very little else will grow there except coca and even if you did, how are you going to get it to market? There is no way, if you grew something up there to get it to market. There is no infrastructure.

Dr. BEDOYA. The peasants form the highlands are coming to the jungle and are planting coca. But before, they did have coffee, good yields, very good yields of coffee, extremely good yields of tea, the best in the nation. They could have again, and there are many other things that could have been done in this area. There are some areas that used to be the cooperative Saipai. Now it is all coca. It used to be in the 1970s and 1960s tea and coffee. But I only want to make one additional point, the Upper Huallaga is a special project that does not have any environmental assessment, despite all the environmental, all the ecological consequences that we are talking here in relation to coca production. That is a real mistake that originally was done.

QUESTION. I just wanted to ask the gentleman his comment about nothing will grow except coca. Did he mean that to apply only to the Upper Huallaga?

Dr. ANTOGNINI. You get these high mountain areas and a lot of the soils are thin, the erosion factor and so forth, it's going to be very, very difficult if not impossible to grow some of these other crops.

Dr. DOUROJEANNI. Certainly, coca is occupying today land which in the past was not utilized and also a great portion of the land that was utilized for corn. By the way, corn is almost as bad as coca in soil erosion terms.

COMMENT. I think we need some numbers. There seems to be a conflict in that people are saying deforestation is one of the big

problems and then he says it is not deforestation of the crops being grown there now. If other crops are being grown, they are not being grown in the forest. So you need to know how many acres are being deforested and how many acres were in actual production in these other crops.

EXTENT OF RESEARCH NEEDED TO GATHER ENVIRONMENTALLY RELATED DATA

Mr. PERL. This raises a very important question that I would like to ask of the panelists. Many of the people here are congressional staffers who have the ability to influence legislation. If they were to recommend funding research in this area—because one of the things that strikes me is a lack of availability of data—what should they be funding? I'd like to ask each of the panelists the type of research project that they think would be needed to gather data.

Dr. ANTOGNINI. I could give you a list, but I think it becomes very secondary to the fact of how are you going to do the research. The State of North Carolina, North Carolina State has an experiment station down there they haven't been able to get to in years. How are you going to solve that? We can come up with great research programs with substitute crops and what have you, but how are you going to get in the field to do the research? When Dr. Christy talks, he'll point out some of the problems we've had in doing research down there. How do you really get all the facts when you can't get in there without getting killed?

Dr. DOUROJEANNI. As a matter of fact, there is not so much need of research to provide a solution to coca and cocaine. It is essentially a matter of political will, both in the consumer countries and in the producer countries.

Dr. BEDOYA. It's another fact that there is a lot of research done in the Tulumayo station, and research done during the last 30 years that is not applied to political and social reasons in the area. However, there are many things that could be done—first, commercialization studies, marketing (that is extremely important), how to help the coca producers work to produce their legal products, and so on. Second, there is a lot of forestry research to be done in this area. This area never was considered as a forest or a national forest until recently. And there is no real research because of that, and that's another point too. Another, third type of research is how to cultivate now in areas where it used to be coffee plantations, tea plantations now turning to coca plantations, how to cultivate again coffee, tea, or other types of products, like bamboo for example.

MIGRATION TO UPPER HUALLAGA VALLEY IS INCREASING

QUESTION. I am interested in migration numbers and how this might help us to understand the dichotomy of people who were previously employed in agriculture in the valley and how many are now. One hears factors of four or six or ten or twelve, which may in fact be the only experience in the world where we have urban to rural migration of any great numbers. I wonder if anyone has the authoritative data there, or perhaps some should be sought.

Dr. BEDOYA. The annual rate of increase of the migration in the 1970's decreased in the Upper Huallaga area. However, in the

1980's, due to the coca expansion, this area has had a huge amount of migrations from the old, the highlands of Peru to this specific area. Moreover, we have a lot of people who come from the urban areas in Peru. Because of the economic crisis they move to the upper jungle. They don't know how to cultivate, they learn from other people and they start coca plantations from one day or another. I understand that in the last three or four years there has been a huge migration of thousands of unemployed to the area of the Upper Huallaga. That means that the rate of increase has considerably gone higher.

I think a lot of people, due to prices and due to the economic crisis, have abandoned the highlands and are not cultivating in a very intensive manner any more. That provokes serious ecological consequences in the highlands, and they are moving to areas that are in relative terms demographic and agriculture frontier areas. So, they try to cultivate in a very extensive manner. But in general terms, the migration from the highlands to the lowlands has created labor scarcity in the highlands. There is not enough male labor force to cultivate in a very intensive or rational manner.

Mr. PERL. Before we conclude the first panel, do any of the panelists need to say something or feel that something important has been left out?

DEVELOPMENT IN ANDES REQUIRES PEACE AND NOT CONFLICT WITH SENDERO LUMINOSO

Dr. DUROJEANNI. Eradication is only one part of a global solution. In addition to the control of the demand, it is essential to offer other opportunities to rural poor, both in the highlands and in the Upper Amazon. The Peruvian Andes (highlands) offer excellent (now wasted) opportunities to fix population, if appropriate investments are realized. Of course, considering the Shining Path guerrilla activity, the first necessary condition is to achieve peace. No development is possible, in the Andes or in the Upper Amazon, under the current situation in Peru.

QUESTION. What is going to be the effect of coke on coca production if worldwide demand for coca is reduced?

Dr. ANTOGNINI. The end result is going to be the same, isn't it, whether you eradicate it with an herbicide or a hoe. If people quit using it, the end result socially and economically is going to be the same—there is going to be no market.

Mr. PERL. My watch shows 14 minutes after the hour, which means we add 7 minutes, which would make it 21 after when we'll reconvene.

PANEL II.—COCA HERBICIDES: ENVIRONMENTAL AND HEALTH CONSIDERATIONS

REMARKS OF RAPHAEL F. PERL, MODERATOR SPECIALIST IN INTERNATIONAL NARCOTICS POLICY FOREIGN AFFAIRS AND NATIONAL DEFENSE DIVISION, CONGRESSIONAL RESEARCH SERVICE

Mr. PERL. Our next panel today is on "Coca Herbicides: Environmental and Health Considerations." And we have what is a distin-

guished and what promises to be a lively panel. One of the key questions we will be examining here is whether it is possible to support the argument that the use of Spike is an environmentally "better" option compared with the ongoing negative environmental and health impact of coca growing and processing.

Our first panelist will be Larry Christy. Dr. Christy is a National Program Leader for Weed Science at the U.S. Department of Agriculture and he is responsible for overall herbicide research in weed science and agricultural chemicals at the Department of Agriculture. Dr. Christy has over 30 professional publications to his name in the area of weed science.

Then we will briefly hear from Eric Rosenquist. Eric is the Inter-Regional Affairs Officer at the Department of State's Bureau of International Narcotics Matters. Eric has varied responsibilities, but what is important for this seminar is he is the person in charge of policy issues relating to environmental aspects of U.S. crop-control programs.

Then we will hear briefly from an environmental scientist and technical consultant to the Department of State, who will provide a concise environmental review of the effects of herbicides on the environment.

Our next panelist will be Alejandro Camino. Alejandro is a well-known Peruvian environmentalist. He is a spokesperson for the Peruvian Foundation for the Conservation of Nature. He is an Associate Professor at the Catholic University of Peru, where he teaches a course on human ecology. He is also a graduate of the University of Michigan and he has published extensively in the area of human ecology, natural resource use and etho-botany of natural plants. What is "etho-botany," Alejandro?

Mr. CAMINO. Traditional native use of cultivated plants.

Mr. PERL. So Alejandro is also an authority on the traditional native use of cultivated plants.

Then we will hear from Stuart Hudson. Stuart is the legislative representative for international programs of the National Wildlife Federation. Stuart has also worked in the past at the Congressional Research Service so that when we say hello and welcome to Stuart, we are not only saying welcome to him, but welcome back.

Finally, our commentator will be Mary Tiemann, Analyst in Environmental Policy at the Congressional Research Service. Mary has published extensively in the field of environmental policy and her specialty at the Congressional Research Service includes international environmental issues and water policy. We also do have in the audience as a participant in the panel Kurt Tarnoff from the Foreign Affairs and National Defense Division. Kurt, could you raise your hand? Kurt is the author of our issue brief on international environmental issues which is available at the back of the room.

I want to point out that we are having run off copies of a State Department publication on herbicide testing which we will be handing out at the end of the session, assuming that the copy people have it in time. If not, it will be during the next session. And with that we would like to start and Larry, the floor is yours.

REMARKS OF DR. A. LAWRENCE CHRISTY, NATIONAL PROGRAM LEADER FOR WEED SCIENCE, USDA

UNITED STATES HAS TWO SAFE AND EFFECTIVE COCA HERBICIDES

Dr. CHRISTY. During the next few minutes, I would like to give you a quick overview of some of the research that the Peruvian government, in cooperation with the State Department, has been conducting in Peru, and some of the research that we have been conducting on several herbicides. These results demonstrate that in fact we do have a safe and effective coca herbicide, contrary to many reports in the press. I will also include some data on the environmental impact of the herbicides, particularly in regards to soil persistence and soil mobility.

The two herbicides currently under consideration for use as coca control agents are tebuthiuron and hexazinone. Tebuthiuron is sold under the trade name of Spike 20P and is manufactured by Dow-Elanco. Hexazinone is sold as Velpar and Pronone and is manufactured by E.I. Du Pont de Nemours and Company.

I will present some data from one of our field experiments at a tropical location. There are some difficulties with doing research in South America and particularly in the Peruvian jungle so we grow coca at a tropical site and conduct some herbicide trials there. On this graph, phytotoxicity is used to indicate the level of control, with ten being a dead plant or maximum effect. This is tebuthiuron at three rates on coca, as compared to the untreated control. At all three rates that were being used (two, four and six pounds per acre active ingredient), complete control of coca was observed within five to six weeks after treatment.

With hexazinone at the lower rate we got some recovery after the initial application. Hexazinone has a shorter half life in the soil, so we're probably seeing some recovery at the lower rate because it is being broken down. In the case of the two higher rates, four and six pounds, we got complete control of coca.

Now I will discuss some of the tests being conducted in Peru. Some of this work began back in October 1987 with phase one and we are now in the middle of phase four. This is the phase one site and very little actual area was treated with herbicides. You can see almost a monoculture here as you'll see in other slides. Here's another view of phase one. There's a lot of different vegetation in this region, but most of these cleared areas, or almost all these cleared areas, are coca in production. You can see the amount of dead trees and note the amount of deforestation that has been occurring. There are dead tree trunks lying on the sides of the hills, but all this area is coca. The area right here is probably a recently planted area or it was a recent harvest area and this area wouldn't have been harvested yet.

Here is a close-up of what we call T-3. This is where tebuthiuron was applied at three pounds per acre active ingredient. You can see this is all dead coca. You can see a strip here where the plane flew over this hill.

QUESTION. How long after the application of tebuthiuron is this?

Dr. CHRISTY. This picture was taken one month after application. You can see the strips in between where the plane didn't quite

overlap the field. It is important to note the lack of damage to the surrounding vegetation. Note the live coca along the tree trunks. This is due to the Spike formulation being a pellet and it probably bounces off the tree trunk, and so we are not getting a uniform coverage there and the coca survives in that area.

QUESTION. We're going to ask two questions. What is the impact on the food chain of these two herbicides?

Mr. PERL. We'll talk about that.

QUESTION. The other one is, do we use these two herbicides in the United States on our fields?

Dr. CHRISTY. Yes, you can go to Hechinger's and buy Spike today. Spike is used worldwide; from the most recent EPA data, approximately nine million pounds of Spike are applied throughout the world. It's used primarily for weed control in sugarcane in Brazil. In the United States about a million pounds are used annually in the desert Southwest to control brush on range land and pasture.

Mr. PERL. As moderator, I'm going to have to ask that we limit the questions to Larry. Save the questions for the end of the presentation; otherwise we won't be able to physically manage the panel. If you have a question about an interpretation of the graph, when it's important to have the graph showing; ask it then, but otherwise please help me out as the moderator.

TESTS SHOW TEBUTHIURON KILLS COCA AND NOT SURROUNDING VEGETATION

Dr. CHRISTY. This is again another one of the T-3 plots and you can see some of the coca that was not affected. This is all basically dead coca in here. Here is a strip that wasn't hit and again you can see the surrounding vegetation is doing quite well. Here is another plot one month after application, showing dead coca. You can see some remaining leaves and you can also see how clean they keep their fields with herbicides. There are few weeds in the fields. Also again note the green vegetation down the hill from the treated area. Some have suggested there might be run-off of tebuthiuron; however, there doesn't appear to be any damage in these areas.

These pictures were taken three months after application, and you can see the grass is coming back in. This brown material in the foreground is a dead coca plant. In the background, note the green vegetation; other plants are starting to colonize these areas. We've taken samples of all the plants starting to grow in the T-3 area. We have 16 different species of plants six months after application, representing 13 different families, and I can give you a list of those plants if you're interested. Another view of T-3, note that the dead coca can hardly even be seen at this point. Here is a banana plant doing very well.

TEBUTHIURON HAS MINIMAL SOIL PERSISTENCE AND HEXAZINONE DOES NOT PERSIST IN SOIL OR WATER

Here is another shot showing some of the surrounding vegetation downhill and the dead coca in the foreground. So it looks as though this is all tebuthiuron. It looks as though we have a very nice herbicide that does a very good job and I think has minimal environmental impact. Now we also were concerned about the persistence

in the field. It's very hard to go in and take soil samples in these coca-growing areas, so we're running a limited trial on these plots in South America and we also have at a tropical site where an extensive soil persistence study is under way. One of the problems also with using a granule or pellet (pronone or hexazinone 10G is a 10 percent granule, Spike is a 20 percent pellet) is uniform distribution and sampling in soil studies. These cartoons depict the distribution of pellets or granules on the soil and show the chances of hitting a pellet during sampling. The data for this type of test can be very variable. We've taken over and analyzed over 1,000 soil samples during the Phase Four study.

This is a graph of the soil residual as percent of applied. This is two pounds of tebuthiuron and hexazinone; you can see it disappears very rapidly from the soil. This is some more data from Peru, Phase Four, and you can see that in this case the estimated half-life is around four months.

Hexazinone persistence is much shorter than tebuthiuron at between .5 and .6 months. In other words, after two weeks half the hexazinone will be gone. The tebuthiruon data is from our tropical site, and you can see a very consistent half-life of 3.7 months. Soil residue levels of one to two parts per million are below the health advisory level from the EPA for tebuthiuron in water. EPA advisory level for tebuthiuron is .5 parts per million. So even at six pounds per acre, we're much below the health advisory level for water.

In summary, then, we have two herbicides that are capable of controlling coca. When you consider the environmental insults that the first panel discussed combined with the minimal environmental impact of the herbicides, one can make a strong argument for eradication. We do have some soil persistence with tebuthiuron, but that may be desirable in some cases. It keeps the grower from coming back in immediately and it does leach some, but we feel it's within acceptable levels environmentally.

Mr. PERL. Thank you, Larry. Eric, you'll present some brief comments and kind of introduce John.

REMARKS OF ERIC ROSENQUIST, REGIONAL AFFAIRS OFFICER, DEPARTMENT OF STATE, BUREAU OF INTERNATIONAL NARCOTICS MATTERS

U.S. REGULATIONS REQUIRE THAT ENVIRONMENTAL POLICY CONSIDERATIONS ARE APPLIED TO OVERSEAS ACTIVITIES

Mr. ROSENQUIST. Larry covered many of the issues relating to the results of the test. I just wanted to deal in this section primarily with environmental and regulatory issues, not with economics. We are required by law and regulation to adhere to environmental compliance procedures similar to any U.S. domestic agency and specifically we're bound by the National Environmental Policy Act of 1969 to do environmental impact statements and environmental assessments on any actions that would have ramifications within the United States. In the case of narcotic crop control, the application of herbicides for eradication, these are probably going to be mostly potential human health effects resulting from ingestion of narcotics treated with chemicals. To give a concrete example, the

application of a paraquatia contact herbicide on cannabis, which was an issue several years ago when we first eradicated marijuana in Mexico. So we are required by law to deal with those issues. We're also required by Executive order, specifically Executive Order 12114 (for those of you who are familiar with NEPA) by NEPA-type regulatory compliance documents on those possible ecological effects of our actions in a foreign country.

What is NEPA? That's National Environmental Policy Act and it basically requires U.S. Federal agencies to do environmental compliance documentation on those things that would have either world ecological or narrow human health effects. Now obviously, by law actions that would be carried out outside the territorial boundaries of the United States are not covered, by definition by NEPA. At least that has never been challenged in court, but there is an Executive order that requires NEPA-like considerations to be applied even to our actions which are conducted either overseas or in international airspace and waters. That's the regulatory framework for what we have to do and we do produce and publish such documents. Much of the data that Larry expanded upon that we are collecting is designed to support regulatory documentation if and when a chemical eradication program were promulgated anywhere in the Andean region. I just state this to give some kind of a regulatory framework for what we are doing.

UNITED STATES HAS IDENTIFIED TWO HERBICIDES THAT ERADICATE COCA WITH MINIMAL ADVERSE ENVIRONMENTAL AND HEALTH EFFECTS

Historically, we've had some problems in identifying a coca herbicide. For years we have used herbicides to control cannabis and opium poppy in various locations worldwide. Coca by its nature is a perennial woody plant, it is more difficult to eradicate, as all woody plants are, and probably through natural selection and thousands of years of stripping it's not a plant that would be very amenable to control through a foliar herbicide like paraquat, for example, that resulted in defoliation. So consequently we have to look, find a chemical that's (1) environmentally suitable and (2) is going to achieve the desired levels of control. We had a small test program in Colombia several years ago. We narrowed down the range of chemicals from six or seven to two of the most promising, which Larry discussed. About two years ago we received permission from the Peruvian government to conduct a small manual test which was done on a less-than-one-acre site which was followed more recently by a larger 25 hectare aerial test. And we view the aerial testing as very important because in any real-life application. Aerial application is the only way that we can go. We narrowed down the chemicals that we wanted to look at to hexazinone and tebuthiuron, one of the primary reasons being that they are granuly applied or pelletized, and you do not have the undesirable effects of aerosol that can damage the surrounding vegetation. The other, and probably more important consideration from the application point of view, in the areas of high rain fall when spray compounds are fully applied, they are not particularly effective.

So far, based on the test data available which is being evaluated both by our college department of agriculture, which has a re-

search agreement with us, and by our counterparts in Peru, the chemicals do not seem to be particularly environmentally damaging. The soil persistence which was an issue of considerable concern to us, particularly in the question of tebuthiuron does not seem to pose a particular problem in this specific environment, nor does leeching, and consequently we think from a purely technological point of view isolating out the other political security and economic issues that there have been several mechanisms that have been discovered that are effective in the eradication of coca with a reasonably minimal adverse environmental and human-health risk.

REMARKS OF STATE DEPARTMENT CONSULTANT

BROAD BASE OF DATA EXISTS FOR EVALUATING EFFECTS OF TEBUTHIURON AND HEXAZINONE

STATE DEPARTMENT CONSULTANT. As explained earlier, the kind of analysis conducted in the foreign environment in Peru is the same as the study of pesticides (hexazinone and tebuthiuron) in the United States. Although procedurally it is somewhat different and the legal requirements are somewhat different, the use of the pesticides in Peru has been examined using the same approach. The risk assessment methodology is basically three different steps: hazard, exposure, and risk. First of all, the hazard analysis means going back and looking at the background available on each chemical, including its chemical and physical properties, its fate in the environment, the environmental chemistry, and especially the toxicity of each of the chemicals. These factors are examined not only in terms of effects on human health, but also environmental effects, including effects on wildlife and aquatic organisms.

The most recent environmental assessment of this program came out about one year ago. It is in the process of being updated again based on these field study data. There is quite a broad data base for these particular chemicals, because they are used commonly in the United States. Although there is a lot of laboratory data as well as field use data in the United States, it is important to look at the behavior of the chemicals in the relevant environment. These tests have allowed us to get some more data on how tebuthiuron and hexazinone behave in the tropical climate. I have two reports with me, one of which is being copied and will be in the back later, giving some of the results of the tests referred to by Dr. Christie. And the other report is the concise environmental review which contains the risk assessment on the use of the chemicals.

EXPLANATION OF CHEMICAL TEST EVALUATION PROCEDURE

There are six chemicals covered in the environmental review, including hexazinone and tebuthiuron. These two chemicals have been emphasized because they are the most effective in killing coca. After looking at the background knowledge on the hazard of the chemicals, the possible routes of exposure are examined. How people might be exposed is considered as well as possible routes of exposure for wildlife and aquatic organisms. The people include workers applying the chemicals as well as possible inadvertent exposure to members of the public. This could happen if there is drift

of the chemical off-site so that the chemical would contact crops or water, or due to runoff, contaminate fish or water that people could consume.

A variety of possible accident exposures was also considered. These could be a fly-over where someone is accidentally directly hit by either pellets or spray, workers spilling chemicals on themselves, or direct application to crops and wildlife or waters that may be a source of either drinking water or consumable fish.

The possible exposures are considered with what is known about the toxicity and an estimate is made of what is the probability or likelihood of some adverse effect occurring. It is difficult in five minutes to provide all the details of the analysis, but I'd like to point out briefly the approach that is taken in risk assessment. A no-observable effect level is used as a benchmark for toxicity. This is a level which in testing, normally over a long time in laboratory animals, has been shown to case no effect. The lab animal is usually fed the chemical every day for a large portion of his life; people would normally get very short exposures, so the use of laboratory animal exposures in risk analysis is very conservative. However, the toxicity endpoints are always uncertain, so a wide margin of safety to the exposures must be used in order to be certain that no harm will really occur. The benchmark margin of safety that commonly has been used by EPA, for example in setting allowable intake levels, is a factor of 100. In looking at these exposures, under ordinary circumstances, exposures are expected to be very much below this benchmark, even given the margin of safety.

SPIKE DOES NOT APPEAR TO BE DANGEROUS TO THOSE WHO APPLY IT, OR TO THOSE WHO USE COCAINE PROCESSED FROM PLANTS KILLED BY IT

There is some possibility of danger to workers applying the chemicals in the case of liquids. For example, dicamba is one herbicide that was studied. However, I'd like to emphasize that hexazinone and tebuthiuron would normally be applied as a pellet. They are inherently safer from the point of view of handling for the workers,but also from the point of view of being able to control the application so that the herbicide goes on the fields where it's intended and doesn't move off-site under the influence of the wind, for example, to water supplies onto other crops. Pelletized herbicides are also safer for wildlife. I'm afraid I'm out of time, but I just wanted to add that other non-threshold effects, such as cancer and the possibility of mutations, were also examined. The data base for these chemicals in the area of toxicity and cancer production is extensive, although not complete. EPA has asked for a variety of chemical studies to try to verify the safety of these chemicals.

Mr. PERL. I wanted to ask one question, something that is not clear to me. After tebuthiuron or Spike would be used, do the leaves fall off the coca bush and then is there a possibility that people then would get poisoned cocaine or chew poisoned coca leaves?

STATE DEPARTMENT CONSULTANT. I didn't mention that, but that was looked at. In the case of sprays, again, they could be applied so that they would be directly on the leaves, and someone could potentially go out and harvest the leaves immediately afterwards. So

the assessment examines the possible exposure from chewing the leaves, the traditional form of use in the area, as well as processing of the cocaine into either cocaine HC1 or crack.

Some of the chemicals have been tested directly during processing, others were analyzed theoretically using their solubility relationships and other chemical characteristics, and it appeared that no significant exposure could occur in processed cocaine. A small amount could be taken in with leaves if they were chewed, but again, it would be expected to be well below the limits expected to be toxic. There also could be a small amount taken up into the plant through the soil, especially in the use of tebuthiuron or hexazinone.

QUESTION. Could you just very briefly restate what your results were on risk assessment?

UNDER ORDINARY CIRCUMSTANCES, SPIKE POSES NO ADVERSE HUMAN HEALTH EFFECTS OR PROBLEMS TO AQUATIC ORGANISMS

STATE DEPARTMENT CONSULTANT. In the case of human health, under ordinary circumstances, no adverse effects were seen due to exposure from a variety of different pathways. Accidents are, of course, something that have to be avoided and in some cases could cause adverse effects. The toxicity of the chemicals to aquatic organisms is something that we were quite concerned with and in most cases, it looked like either through drift off-site or runoff that the chemicals would really cause no problem to aquatic organisms. One exception to that was triclopyr which under runoff conditions may represent a risk of causing significant effects to aquatic organisms. It's not one of the two finalists. It has been shown to kill coca in the past, but it's apparently not at all reliable.

REMARKS OF ALEJANDRO CAMINO, DIRECTOR OF DEVELOPMENT, PERUVIAN FOUNDATION FOR THE CONSERVATION OF NATURE

PERUVIAN ENVIRONMENTAL GROUPS LACK DATA ON USE OF HERBICIDES TO ERADICATE COCA

Mr. CAMINO [Remarks partially present data published in "Coca: Del Uso Tradicional al Narcotráfico" in *Coca, Cocaina y Narcotráfico. Laberinto En los Andes.* Diego Garcia Sayán, ed. Lima, Comision Andina de Juristas, 1989]. The Peruvian environmental movement has been aware of the detrimental impact of the expansion of coca cultivation and subsequent deforestation, or reduction of biological diversity, and also the impact of use of agro-chemicals in coca processing for cocaine. When the proposed project for use of agro-chemicals or herbicides to eradicate coca was proposed for Peru, there was major concern in the environmental movement to find out what the whole project was going to be like. Actually, one thing that should be noted is that the Peruvians found out that coca-eradication experiments using herbicides were going on through foreign press releases; it came out in the papers. At first, there was never a word from the Peruvian government stating that the experiment was going on. This is the first time I am having the opportunity to learn of the preliminary findings of hopefully sound

research on Spike environmental impact on coca plots. The Peruvian Foundation for the Conservation of Nature participated in the commission which was set up with participation of seven Peruvian NGOs. These organizations, some of which are professionally concerned with issues related t the impact of ago-chemicals on the environment, and with the impact of illicit and expanding coca cultivation and its detrimental impact on the environment, were willing to participate. Once the commission was set up, however, problems arose from the very beginning in the operation of this commission. The head of the commission, General Zarate, in charge of the eradication program, never provided the members with the research project dealing with the planned experiments. The members requested all this information on several opportunities; requests were made on letters, sent on several occasions. These were never answered. Some of the letters were sent to the officers responsible for the research project. I have with me a copy of the letter sent to Mr. Pete Jacoby from Texas where some substantial questions were made on the type of soil and water samples that were going to be taken, as well as on the impact on aquatic and terrestrial flora and fona, and on the samples to be taken, whether there would be any experiments in neighboring areas, etc. These were never answered.

From the beginning the members of the environmental groups were very concerned to finding out the project's methodology, and we were all willing to collaborate in determining whether there would be or not an environmental impact. The only reports that environmental NGOs were able to get was a brief report stating the efficiency of the agro-chemicals in destroying coca, not on the environmental impact of the herbicide. We cannot blame the laboratory for this or the group doing the research. This is certainly something to blame the people in charge of the eradication program. The commission confronted several problems throughout its work. General Zarate didn't show up at two of the meetings which were called, letters were not answered and finally a major scandal broke out. When the commission was established, the Peruvian Office for Natural Resource Evaluation (ONERN), a government office, was urged to sign an agreement aimed at conducting the environmental assessment. When later on, the *ad interim* director of this bureau resigned, the new director, who was a professional engineer, determined that, on the basis of ONERN capabilities, they did not have the required conditions to conduct a serious assessment. He sent General Zarate a statement in which ONERN declined to participate in the assessment. The next day the new director found on his desk a letter stating that he resigned his position as director. Surprisingly, and this is something that should be noted, the resignation did not come or originate at the proper source, which is the President of the Republic (since ONERN depends directly on the presidency). Later on, it was proven that the resignation was prepared by, and came directly from, the Ministry of the Interior, which is not the authority that supervises ONERN. An explanation of this transgression was never given.

DATA INDICATES THAT NEW COCA PLANTINGS FAR EXCEED AMOUNT OF CROPS ERADICATED

The main concern of the environmental groups regarding the project has been that the assessment cannot be exclusively based on an evaluation of the impact of the agro-chemicals on the environment. *Our main concern has been the impact of the eradication program in itself.* In the previous panel somebody mentioned the paradoxically contradictive impact of earlier manual eradication. In the early 80s I worked as a field researcher in the Huallaga Valley and I remember interviewing the Mayor of Tingo Maria, an important town in the area, about the eradication program conducted at that time by manual means and/or mechanical means. He stated that peasants who voluntarily gave up their hectare of coca were paid in compensation. The Mayor of Tingo Maria, who later was killed by the drug traffickers, at that time told me that with the money received peasants went around the hill and invested in two new hectares of coca. There is a recent publication that states that for every hectare eradicated in Peru, 15 new hectares have been planted in the last 10 years. Certainly, this data needs to be certified. We don't have field data from the early 80s. We are working on rough estimates. Finally, with regards to the concern for substitution and replacement of coca, we are quite aware that there are an important number of crops, which, under certain conditions, could be more profitable than coca.

MOST COCA IS GROWN IN AREAS WHERE FORESTS ARE PROTECTED BY LAW

However, it should be noted that 60 to 70 percent of the soils in which coca is grown for illicit trafficking correspond to soils that are scientifically classified as *protection forest* by the official government natural resource evaluation system. There is a serious concern whether those lands could be devoted to any sort of sustainable type of agriculture or to forestry or to any other productive strategy.

A NUMBER OF QUESTIONS STILL NEED TO BE ADDRESSED

I would like to finish with three questions to our previous panelists. One, with regard to mutations in the coca plants due to herbicide spraying, a U.S. researcher recently brought up the issue of whether the use of these agro-chemicals would affect changes in natural crop diversity, that some varieties will be able to resist herbicides and result in a new generation of varieties that will be resistant to these agro-chemicals. Second, without questioning the validity of the experiments, why were Peruvian scientists, or Peruvian scientific institutions not involved or invited to participate in the environmental assessment project? Why were they excluded? And finally, there was a reference made in the panel to the vegetation surrounding the coca plantations subject to the experiment. The previous panelist stated "you can see that vegetation is growing." I would like to know if there was an evaluation of the type of vegetation growing in the adjacent areas to where coca was sprayed with tebuthiuron. Did the area under experimentation and adjacent fields undergo a regular process of tropical forest succes-

sion? What type of vegetation grew afterwards? How were insect, bird life and other fauna affected? Was this ever considered in the assessment?

UNDERSTANDING TRADITIONAL USE OF COCA LEAF IN ANDES IS CRITICAL TO UNDERSTANDING COCA CULTIVATION IN THE REGION

A final word I would like to say: There is a very important side in the coca issue that urgently needs to be dealt with in a panel, and that could be crucial in the future since it is critical to the understanding of the whole coca problem and drug trafficking. I am speaking of the traditional use of coca leaf in the Andes. As an anthropologist, I am aware that this is a very critical area in the understanding of the coca cultivation reality and that by learning from this tradition we may advance towards finding a solution to the problems related to illicit coca production in Peru.

Mr. PERL. I want to ask just one question. What in your presentation do you feel is the most important point?

SUMMARY OF MR. CAMINO'S MOST IMPORTANT POINTS

Mr. CAMINO. Two points, that the so-called environmental assessment conducted was more of an efficiency assessment than an environmental impact assessment. Moreover, the results were never made available or have not been available to Peruvian organizations. Nobody has been able to find out how the research process was conducted. A second point: That eradication, as was already stated in the previous panel, seems to have aggravated the problem instead of giving a solution.

REMARKS OF STEWART HUDSON, LEGISLATIVE REPRESENTATIVE FOR INTERNATIONAL PROGRAMS, NATIONAL WILDLIFE FEDERATION

ENVIRONMENTAL AND HEALTH COSTS OF COCA PRODUCTION MAY EXCEED THOSE OF USING TEBUTHIURON

Mr. HUDSON. I'm going to begin by sketching a little bit of the history of the concern of the environmental community at least in the United States on this issue, and I think initially the focus was mostly on the environmental and human health aspects of the use of tebuthiuron as a means of eradicating the coca crop in Peru. Subsequent to that initial concern, and as a result of our consultation with Peruvian environmental and indigenous groups, we became aware that the issue was more complex and that we should view it more holistically and take into account the environmental and human health aspects of production itself.

And that point has been made in great detail by the first panel. There are costs associated with production and those costs may in fact exceed the environmental and human health costs of using tebuthiuron, and in fact this is not new in terms of the position of environmental groups. Particularly in Peru, I was going through my file and discovered a document from September 2, 1988, that is a position paper of the major environmental groups in Peru which states that the production of coca for cocaine is a serious environmental problem, chemicals used in the process pollute rivers, etc.

and lead to deforestation and desertification, and the cocaine trade leads to destabilization in the government which makes it difficult to undertake environmental activities. One of the concluding points of this document was that coca for cocaine production is a serious problem and it is the responsibility of all Peruvians to halt its production in whatever form.

POLICYMAKERS MUST ADDRESS WHETHER ERADICATION IS EFFECTIVE IN DEALING WITH THE PROBLEM OF COCA PRODUCTION

The more holistic view of this issue is not new. That does not, however, mean that we should not address the basic question of whether or not eradication through whatever means is an effective means of dealing with this problem, and I think that is the central question of this hearing or conference today. We have to look at the environmental impacts and human health impacts of tebuthiuron, the contamination of ground water, the persistence in the soil, the impact on plant species, etc. I think we need to realize, as some have already stated, that there are some very serious problems.

I always like to quote the *Washington Times,* which states in an article of June 1988 that "plant killing herbicides the State Department plans to spray on coca producing bushes in South America would poison farmland for up to three years, endanger plants, and cause violent reactions in humans exposed to the chemicals according to government reports." Now we have more information coming out that suggests that those effects may not be as serious as originally thought, but those earlier findings have to be taken into account. I think a lot of work has been done by Greenpeace as well on looking through the EPA documents and trying to isolate the environmental and health aspects of Spike, but again the concern is: does eradication actually deal with the most serious problem, which is production?

And stating some facts that were provided by the State Department's representative Anne Wrobeleski at a previous hearing in Congress, the U.S. crop eradication program—and this is as of June 1988—succeeded in eliminating only 1400 hectares of coca out of 150,000 hectares of coca cultivation, or less than 1 percent of the crop. Now assuming we've done five times as well since then, which is an assumption, that means that we are now eradicating through whatever means we are using now about 5 percent. We have heard a great deal of evidence that I don't think has been presented previously that what we are seeing is not necessarily a reduction in the amount of land being brought under cultivation for coca.

ERADICATION MAY BE STIMULATING INCREASED COCA PRODUCTION

In fact, the point that Alejandro Camino made was that some of these eradication measures are actually stimulating increased production. This is seen when one takes into account the social mechanisms of the small cultivators to respond to eradication, which is if I'm going to have the danger of my plot being eradicated I better have three plots. So in case one of them is eradicated, I'll have two more that are safeties. Now that is new information to me and I

need to study that to know whether that is factually correct, but the point is that I think we can show you can use satellite images to demonstrate that production is spreading in a wider area. It's moving to the east in Peru, it may be moving into Brazil and I know for a fact that it is expanding in Bolivia.

WIDESPREAD ERADICATION IS NOT A REALISTIC OPTION

I think if one sits and talks with AID officials who are involved in this, as I have done and others have done, they realize there is a certain fiction going on. That this is doable, that's the fiction. That eradication is doable. And I think the fiction remains because there is so much pressure to do something about this problem. What I am suggesting is that I don't think eradication is, as others have pointed out, going to work for a variety of reasons that have already been pointed out. I think it is still worthwhile to look at the environmental and human health aspects of Spike, even though we agree that the problem is essentially on production.

DEMAND IS ALSO RESPONSIBLE FOR SPREAD OF COCA PRODUCTION

I wanted to pull back a bit and also go into greater detail about sort of how the environmental community, at least in this country, approaches this. As we enter the next 20 years of the environmental movement, there is a certain reinvigoration, a change of thinking, which is that problems are becoming more global in nature. We're observing that, but we have to be aware that even problems that we observe in other countries may have their causes here, and this issue is a case study of that.

The problem which I think we're all becoming to realize is production and refinement of coca for cocaine. The root cause of that is demand in this country and we have a responsibility here, and I think that the only way you are really going to address the problem is to reduce the demand. A few other points I wanted to make: Alejandro Camino touched on the fact that the questions we are raising here today are raised in this special conference held in the United States. These questions of environmental concern, human health concern should be part of a regular process. We are fortunate to have that process in this country, but evidently it's not working in Peru. So the first point I want to make is I think we need to address that process issue and ensure that an environmental assessment is complete, that it is available, and involves not only environmental groups in Peru but those directly affected by this eradication. The second point I want to emphasize is that eradication, to the extent that we know anything about it in terms of coca, has resulted in a spread—well, let's put it a different way. The evidence is that there is a spread of coca cultivation which is in part due to eradication, but also due to demand.

OPTION OF CROP SUBSTITUTION PROGRAMS SHOULD BE EXPLORED IN GREATER DETAIL

The last point I wanted to make is that if we do something about demand, and there is a war on drugs in this country and you can evaluate that however you like, someday there will be a reduction in demand and I think we as U.S. citizens need to ask ourselves a

question about foreign policy which is: when that demand is curtailed and when coca production declines, coca for cocaine, we need to ask ourselves how do we want to be remembered or presented in these areas where there are small farmers and these are important political issues not only for ourselves but more important for the government of Peru? Do we want to be remembered as the people who came by and dropped the pellets of tebuthiuron that ruined the best economic production device that these people have seen in their lifetimes or their parents lifetimes, or do we want to be seen in some other light? We know that crop substitution programs are exceedingly difficult in the current economic context in which these people live, but I think that is an area we should explore in greater detail.

COMMENTS BY MARY E. TIEMANN, ANALYST IN ENVIRONMENTAL POLICY, ENVIRONMENT AND NATURAL RESOURCES POLICY DIVISION, CONGRESSIONAL RESEARCH SERVICE, AND PANELISTS' RESPONSES

WOULD ENVIRONMENTAL AND HEALTH DAMAGE OF ERADICATION BE LESS THAN THAT OF COCA PRODUCTION AND PROCESSING

Ms. TIEMANN. Based on the panelists' statements, it could generally be said that given the data that is available—and there seems to be some need for additional research—a fairly broad consensus exists that the potential human health and environmental effects from the eradication program as proposed and being experimented with currently could possibly be less extensive than those effects attributed to the continued production and processing of cocaine. Nonetheless, there are some disagreements our panelists Eric, John and Larry could address—specifically the allegation made in the *Times* article—and give us some more information on those health effects and environmental effects alleged in the *Washington Times* statement.

Mr. ROSENQUIST. First of all, this is old now by some period of time. It is certainly true, tebuthiuron is used in the United States in arid regions for pasture control, specifically in Texas and the American Southwest. The date is June 8, 1988, the *Washington Times.* I don't know which one to quote, number four, "Plant-killing herbicides the State Department plans to spray on cocaine-producing bushes in South America would poison farmland for up to three years, kill small birds and endanger plants and cause violent reactions in humans exposed to chemicals, according to government reports." There is no such Government report: I don't know what this is referring to.

I guess they attribute to them; they don't attribute to the statement at all. I can address one or two of the issues here. Yes, it's true that in arid regions of the southwest where you have a temperate climate and low rain fall there is a problem with persistence in tebuthiuron. That's one of the issues that we probably put on the foremost of test programs in Peru. All we can say is based on the empirical evidence that in a more humid area, with higher temperatures and greater rainfall, persistence does not seem to be particularly a problem.

Dr. CHRISTY. We're conducting the test in two tropical locations with the data agreeing between the two locations. The rates are lower and I'm not sure what report they're referring to, but half-life is much less than three years.

Mr. ROSENQUIST. This is not a toxic chemical; that's just a fact. In a range of toxicities, it's relatively low. So it wouldn't be causing a wholesale wiping out of birds or animals.

Mr. HUDSON. I think what they are referring to is, and now far be it from me to accuse the *Washington Times* of a disinformation campaign that's a little mind boggling, but what they are referring to, and I think maybe they are overstating it, is an EPA pesticide fact sheet dated July 31, 1987, and I think if we want to get serious what we're talking about is updating what was in that article. We've identified some gaps in knowledge that you all have identified that data is still incomplete in some areas; in other areas you're confirming some of your earlier findings, but I think as I recall an earlier statement by the Peruvian government when asked about whether they were going to use Spike they said first we get the information, then we decide. And I think there is still some information lacking.

Mr. ROSENQUIST. And they haven't decided. Peru is an independent country and will decide when they decide.

COMMENT. You also said that it would never happen in the Garcia administration.

Mr. PERL. Let me as moderator kind of jump in again here and give the floor back to Mary, who has some comments to make.

Dr. CHRISTY. We had a question concerning herbicide resistance in the coca crop. Tebuthiuron was first registered in 1974 and we haven't seen any herbicide resistance in any plants or any areas where it is currently being used. I can't say it will never happen, but I seriously doubt that it would happen. Also, we did not do any evaluation of the surrounding vegetation. Over the last couple of years we have addressed some of these environmental issues with our subsequent studies. We've asked many times what any of the countries in South America want to know about the herbicides. We will attempt to answer any questions that they have. But we have not received an answer to date.

LIST OF ADDITIONAL ISSUES WHICH NEED TO BE ADDRESSED

Ms. TIEMANN. I would just like to add a few more comments; then we'll get back to the panel's questions which address the heart of this gathering today. Clearly the activities and maybe the apparent lack of enthusiastic support on the part of the Peruvian government can be attributed to the fact that continued cocaine demand makes coca cultivation so lucrative that it creates a strong conflict within the country on whether to change its products and policies. From the comments made here there seems to be there a lack of involvement by the Peruvian government. I'd like the panelists to address that as we go on, as well as the lack of public participation in the research planning and design of the programs. I would like that explained to us also. In the health-effects area, it's clear that there is more research to do. In regard to evaluating the routes of exposure, it is uncertain how thoroughly this has been in-

vestigated. I would like to see addressed whether inhalation has been considered as one of the potential health-effect exposure routes for people on the ground since there seems to be a large influx of people into the area for the purposes of taking advantage of cocaine production. Finally, coca has for centuries been a legitimate part of the culture and the economics of the area; the next panel will address some of the social implications that the environmental discussions have brought up as well.

DISCUSSION

MASSIVE ERADICATION MIGHT NOT BE REQUIRED

Mr. PERL. Thank you, Mary. Before we open up the floor to give you the opportunity to ask your questions and perhaps pursue some of the issues Mary has raised, I think one thing that is very important that we keep in mind also is how much eradication would actually be necessary to do. I remember in law school they talked about a judge sentencing somebody and he said, "We're sentencing you to jail not because you've stolen a sheep but that others will not steal sheep." And the question is, once one begins to eradicate on a massive scale in one area, will in fact farmers begin to stop to produce or would it be necessary to eradicate that last hectare? The threat of eradication might be almost as effective as the eradication itself and this is something that I'm throwing out for consideration as we continue along in our discussion.

FEASIBILITY OF CROP SUBSTITUTION PROGRAMS

QUESTION. Mr. Camino said that there are some crops which are more profitable than coca might be. I've only read anything that is the opposite of that statement. What are those crops? Could you explain that and what is the feasibility of setting them up?

Mr. CAMINO. First of all, a piece of information related to your last statement. When the word spread around the peasants of the Huallaga Valley that their coca plantations were going to be sprayed with Spike, people started new crops in the neighboring regions. Just keep in mind that peasants are aware that they have the time to start their new plantations elsewhere because the Peruvian government has decided to postpone any decision and transfer it to the new government coming in after July of 1990. Just the word passed around triggered migration elsewhere. I would like it if we could have reliable statistical data. What is the significance of this coca migration into neighboring valleys? With regards to substitute crops, there is not discussion about the fact that there are crops which, under certain conditions, could offer better pay than coca. You have probably heard that right now the new fad around the Peruvian substitution program is the silk worm; the silk worm could be a "solution" to the problem because it is three times more profitable than coca as long as the market is not saturated. Palm oil has also been suggested. By the way, the Peruvian government owns and runs a major oil palm operation in the Huallaga that recently defaulted and went broke because they had difficulty in getting workers because cultivating coca elsewhere is more profitable and because of problems of transportation of the oil out

of the area. Efficient communications to assure a market for adequate alternative products seems to be one of the most critical problems. You can get coca paste out of the Huallaga Valley by airplane, the most efficient way into Colombia and then into the states. It is very difficult to get the oil from the oil palm into the world market out of the same valley—or any other crop. There are certainly ideal substitute crops. Another problem is whether the technology to grow those crops is available to the local farmers if those crops are not environmentally detrimental. Some people have questioned oil palm due to their belief that it is environmentally inadequate. Finally, you should be aware that as you reduce coca production for cocaine, what will assure us, following the logic of the market economy, that the price of cocaine will not pick up in the market? If you were to reduce production and not demand, obviously, the price of cocaine is going to go up in the market and that means that it is going to be more attractive to produce it than it is today. The logic of economics—and I am not an economist—the way I understand it is that if you reduce production and you don't reduce simultaneously the demand (which seems not to be the case—the demand is not being reduced), it is likely that the price of cocaine in Union Square, New York, is going to go up. And that means that there are going to be more peasants stimulated to grow coca. This is another of the questions raised by the eradication programs. You can eradicate coca. That will make the price of cocaine go up in the market. The price of cocaine has been dropping in the last years due to the expansion of offer. But as you reduce offer and don't reduce demand, what will assure us that the price won't start picking up, which will turn into a stimulus for renewed coca production?

NEED TO EVALUATE WHETHER ERADICATION CAUSES FARMERS TO MOVE AND PLANT COCA ELSEWHERE

QUESTION. This is directed to anyone who can answer it and, Mr. Hudson, I think you hinted at the question, but is there a distinction being made when you are evaluating whether eradication is working or not? Is there a distinction being made between those who are new to production and those who have been punished by having a crop being eradicated and then moving elsewhere?

Mr. ROSENQUIST. First of all, there is no eradication technically in Peru, and even in Colombia where the statement is made that there are people being pushed because of the economic pressure of eradication into adjacent areas or other pursuits, I have to temper that with the fact that there is very, very minimal eradication going on.

Mr. PERL. Part of the point made, again, was that the threat of eradication, the psychological mass hysteria; expectations are self-fulfilling or have an effect here.

Mr. ROSENQUIST. I would dispute that there was great mass hysteria that occurred. There was a rumor that went around for a couple of weeks when this was first leaked to the media.

Mr. PERL. The title of this panel is "Coca Herbicides: Environmental and Health Considerations" so please try to focus your questions on the issue of the environmental and health impact:

should we spray Spike, shouldn't we spray Spike and what are the issues.

QUESTION. Along that line, it was Dr. Christy who raised an interesting point that most of the Spike is being used in Brazil, if I'm not mistaken. Has there been any environmental impact, is it a similar environment to what we are talking about, has anyone looked at the use of it there? And along the same line, I know there has been some coca eradication in Colombia, perhaps minor, and also some coca eradication in Ecuador. The Ecuadorians are very proud of their eradication method. Were they using manual eradication or were they using the same type of environmentally dangerous chemicals? So if you could just address the Brazilian use of herbicides, which I think is new. I don't think most people know that it was being widely used in Brazil as well as elsewhere.

Dr. CHRISTY. I'm not aware of any undesirable effects, but I haven't seen any reports either way as far as using tebuthiuron on sugarcane in Brazil. So I really can't comment on that.

Mr. ROSENQUIST. The Ecuador experience may not be terribly illuminating because coca production in Ecuador was diminishing and manual eradication could have taken care of 5,000 hectares very easily in one year, and that might have taken care of all of Ecuador's.

Dr. CHRISTY. A Colombian told me that many of their growers were going out of business voluntarily because they were being put out of business economically by the Peruvians, who were producing leaf at a lower cost and they couldn't compete and so they were going to other crops. The drug content of the Colombian leaf is not as good as Peruvian coca leaf. In addition, the Peruvians were doing a much better job of producing coca leaf and they were putting the Colombian growers out of business.

DAMAGE FROM COCA PRODUCTION AND PROCESSING COMPARED WITH DAMAGE FROM SPIKE

Mr. PERL. Let me address a bottom-line question to the panel. I'm not saying that we should or should not spray Spike. But given the option, weighing the damage that the traffickers do to the environment and the environmental health considerations of trafficker activity and the activity of the growers versus the environmental and health considerations and potential damage from the use of Spike, which is greater?

Dr. CHRISTY. From the data I've seen, we have three environmental insults occurring as a result of coca production; deforestation and the erosion associated with it; secondly, dumping of chemicals used in extracting and processing the drug; third, the pesticides used in production. We feel that using tebuthiuron eradication is much more desirable and will have less environmental impact as compared to continued production. We are only going to have to control approximately 75 percent of the plants in a field. You don't have to get close to the surrounding vegetation. With this level of control the grower is going to abandon the field. So one passes down the middle of the field with an airplane with a 100-foot swath, and the grower will be out of business. So I think when you compare the environmental results it comes out on the side of

eradication. When you consider several aspects of the agronomics of coca production, eradication appears even more desirable. First, coca seeds are only viable for 10 to 15 days; they cannot be stored. This, combined with the fact that coca is a perennial crop and takes 12 to 18 months to bear fruit and sufficient leaves for harvesting suggests that eradication could have a major impact on production. They would need 8 to 10 billion seeds hand-harvested and hand-planted to return to current production levels. Wipe out their crop and you wipe out their seed supply. The growers will not be able to move down hill and replant. They will not have the necessary seeds. When you consider this and less impact on the environment, why are the environmentalists opposed to eradication?

Mr. HUDSON. Well, let me help. There's an assumption being made that eradication can work. That's the assumption you're operating under. If you look at it another way, which is you're going to eradicate here and the problem is going to migrate over to somewhere else, it's difficult to isolate the factors now. Is the migration that's occurring in Eastern Peru, there's no doubt about that, due to the fact of increased demand or other reasons? Is it because their fears are that the eradication is going to take place in Huallaga, so they need to go somewhere else to grow the stuff?

Mr. ROSENQUIST. That's a very speculative statement. I mean the things that are driving increased cultivation are twofold. One, there is simply increased demand and the promise of markets, a purely economically driven issue. And I think you have to bear in mind that the people who are cultivating coca aren't making a great deal of revenue from this. And that brings me to the second issue. It's the lack of other economical alternatives which is also moving them into this. It's not just simply a demand for coca though it is certainly largely a demand for income. It's also a question of viable economic alternatives, problems which are generic to most of the developing world.

Mr. HUDSON. You say that we're speculating, indeed we are. I do, and I think that what is happening is that there is no evidence that eradication of coca has been successful anywhere else so we are in an area of speculation. Let me finish what I am saying, please. We are in an area of speculation and theorizing about what the impact of this eradication is. We believe that what is going to happen with this policy is that there is going to be a migration to other areas because the demand remains high. Essentially what you are talking about is dealing with the costs of what I agree is the major environmental problem, which is the production and refinement of cocaine, but the assumption you are making is that eradication is going to remove those costs. Our fear is that it is going to add to those costs. You are going to have the costs of the herbicide whatever those are, whatever those are determined to be, and then you are going to have the same costs of production and refinement somewhere else.

Mr. PERL. I wanted to ask our State Department consultant a question, not from a political perspective, or not that we're advocating the spraying of Spike, but just in terms of environmental and health impact. Do the traffickers do more damage or would Spike do more damage?

STATE DEPARTMENT CONSULTANT. Well, let's look at the nature of the chemicals: first, tebuthiuron and hexazinone. I'd like to refer back to an earlier question about inhalation danger. There really is none from these chemicals, especially the pelletized formulation. The chemicals on an earlier slide that are currently used by the growers are very much more toxic, especially paraquat. Another kind of evidence for dangers of toxicity not referred to earlier is looking at the history of poisoning incidents. We can't use humans for test animals, but we do go back and look at the history of use, and for paraquat especially, there has been a long series of poisoning incidents, including deaths. A Peruvian government official who worked in the Huallaga Valley indicated that the number one cause of people coming into the hospital was pesticide poisoning.

Mr. PERL. Any questions from the floor relating to coca herbicides?

AFTER USE OF SPIKE, OTHER CROPS CAN BE GROWN IN THE SOIL

QUESTION. I think your slides depict something which you seem to have passed over. If you spray with an herbicide and eliminate coca, in all likelihood you also eliminate the coffee, tea, citric crops and farm labor and your cultivator will move to another piece of jungle and replant.

Dr. CHRISTY. If you look at the slides, the ones I've seen—and I admit I haven't been down there to look at this—you see nothing but coca and you see other plants coming in very rapidly after that.

COMMENT. I agree with you. I'm talking about the farm labor has cleared the jungle.

Dr. CHRISTY. One thing I should correct right now. We don't spray. This is not a spray application. It is a solid formulation that has a lot of desirable applications for aerial application.

COMMENT. When those individuals no longer have an economically viable piece of land, they'll move. It's a question as to where they'll move to.

Dr. CHRISTY. This land is economically viable. They can go back in there and plant as we showed. There are other plants you could plant in there within two months. You could plant other crops and in fact we have such a study under way. We didn't have time to describe that, but we have a study under way where we are planting back in after application of these herbicides to see how soon, and what crops, they can plant.

Mr. PERL. I think the point the gentleman wanted to make was in his opinion and this ties in with what Alejandro Camino said, if you begin to apply tebuthiuron to certain coca fields people will do damage to the environment by going to new areas, cutting down the rain forest, and planting coca again.

Any other questions relating to the use of herbicide? The gentleman in the front row.

DOES ENVIRONMENTAL COMMUNITY CONSENSUS GO BEYOND "JUST SAY 'NO' TO SPIKE"

QUESTION. I believe there was a successful eradication program of opium in Turkey and that did work, so to say that eradication itself

doesn't work I think is incorrect. Also, what does the environmental community have to offer other than just say "no" to deal with this problem? That seems to be the only thing I'm hearing that the environmental community really won't support anything other than demand reduction. Is there something else that can be offered to deal with the problem?

RESPONSE. I think that is a very good question and I've been thinking about that because it does tend to get reduced to saying you've got to deal with the problem just in this country. I think there can be an exploration of some of the crop substitution though I'm not saying what about the success of that. To me it's more like if you're going to be less than successful, that's a better way of being less than successful than eradication. But in this country, I think that it may be a strange enough world that environmental groups might get involved in drug policy in this country and offer some sort of support for efforts to reduce demand here. Add another argument for people saying "no" in this country which is the environmental damage that is caused in places far afield. Those are limited responses, but I don't think because we don't have a good idea of specific yes answers that we go ahead and do something we know, or at least we believe, is not going to work and only add to the costs that we already observed.

Mr. PERL. Let's get a Peruvian environmental perspective on this.

Mr. CAMINO. Peruvians have been chewing coca leaves for 6,000 years and, moreover, there are at least another 20 psychoactive plants which are widely used in our traditional cultures. In Peru, we have, fortunately, not ever been posed with the types of drama that you are facing with the drug problem in this country. It is quite clear to us that the problems related to drug production of coca for illicit drug trafficking are something which came into Peru in the last 10 years. We were not the ones who pushed for it. There is no discussion that now the market is being affected and being promoted by drug traffickers as well; it should be borne in mind that whatever policy is taken, what happens in terms of the demand and the social conditions in the United States affects the overall situation, a matter related to offer and demand of cocaine.

Mr. PERL. Let's take two more questions before we close this panel, if there are two questions.

RELUCTANCE OF ELI LILLY TO SELL SPIKE FOR ERADICATION

QUESTION. When the Spike issue arose in the summer or spring of 1988, Eli Lilly, the manufacturer, almost immediately came out and said they would not sell Spike for varying reasons. What is the status of that? Has Eli Lilly suddenly changed its mind or have they lost their patent? Who is going to be producing this for application, and also does the EPA still require labels on Spike containers that say "Do not apply to water or wetlands" which was an issue in the summer of 1988? My question is, isn't Upper Huallaga a wetland by every definition of the word?

Mr. ROSENQUIST. No, the Upper Huallaga is not a wetland. Yes, the label warning is required. As far as Eli Lilly is concerned, basically very little has happened. There were a series of concerns that

Eli Lilly expressed in their initial discussions with us that primarily related to questions of indemnity and third-party liability that had little to do with the events as they ensued. What happened, as you probably are aware, is that there was a great deal of immediate attention to this. The corporate headquarters of Eli Lilly were picketed by environmental groups and soon thereafter they made the announcement in the press which you are alluding to. I believe that was in March that they stated they would not under any conditions sell the product and as far as we're concerned that decision still holds.

Dr. CHRISTY. I'd like to comment on the label question. You have to be very careful about how you read labels because a lot of times, for example, tebuthiuron is not labeled for use on sugarcane in the United States and it's because Dow-Elanco or, at the time, Eli Lilly did not choose to do that. This was because there is not enough sugarcane grown in the United States to make it worthwhile, and they didn't want to go through the requirements for a registration. You have to be very careful how you deal with some of those label restrictions because they may not have done the testing to allow them to put it in that area because they didn't plan to sell it in that area, whereas they did do the labeling work for selling it in sugarcane in Brazil.

STATE DEPARTMENT CONSULTANT. I would like to make another point regarding the use of the chemical. Tibuthiuron in the past has been used for ditch bank treatments in the United States, so application in proximity to water is a very different thing than application to wetlands.

FEASIBILITY OF LIMITING COCA GROWER ACCESS TO PESTICIDES

Ms. TIEMANN. Given the importance explained by the earlier panel of Sevin and other pesticides to a successful plantation production of coca, has anyone considered the source of most of those pesticides and possibly curtailing some of the input of pesticides that help get such an effective crop out of the areas?

Dr. ROSENQUIST. That's a scientific question and a foreign policy question wrapped up into one. I think from just a foreign policy point of view it would be obvious since pesticides are required in most of the world for agricultural foodstuffs.

Ms. TIEMANN. Is the issue that pesticide export controls couldn't be directed specifically enough to be effective, and that such an effort would be too generic in its effect on the availability of a particular pesticide in a country?

Dr. ROSENQUIST. I would have a hard time visualizing how you could implement such a policy.

Dr. CHRISTY. There is basically a black market in those pesticides. We've been told in Peru, for example, Temix, which Joe didn't list, goes out the back door faster than it comes in to distributors. People who want to use it legally cannot find it. It comes in and goes right out the back door, and I think you'd find there is a black market in these pesticides. They are not labeled for this use obviously, just like parathion is not labeled for use on marijuana in this country, but we're pretty sure that the growers in this country

are using it, but they're growing illegal crops so it doesn't matter; they're using it illegally.

BIOLOGICAL RESEARCH ON COCA CROP CONTROL IS BEING EXPLORED

Ms. TIEMANN. Is there any biological research going on for coca crop control?

Dr. CHRISTY. For these crops, yes. Any promising developments? We're exploring that. One of the things we're exploring is the insect that Joe showed. We are considering it as a possible biological agent, but that's very new research and it will be several years before it is available.

Ms. TAFT-MORALES. Is that insect that you were talking about coca-specific, or does it destroy other crops as well? Would the farmers still be using those herbicides to protect the new crops from those insects?

Dr. CHRISTY. We're told that it's coca-specific, but that has to be evaluated before we could use it as a biological agent, so we're in the process of doing that.

Mr. PERL. Well, I thank our panel very much. It's now 11:47. We'll take a six minute break, we'll be back at 11:53 and I encourage everyone to stay for our final panel. I think it will be a very stimulating discussion.

PANEL III.—ECONOMIC, POLITICAL, AND SOCIAL ISSUES AND OPTIONS FOR POLICYMAKERS

RAPHAEL F. PERL, MODERATOR, SPECIALIST IN INTER-NATIONAL AFFAIRS, FOREIGN AFFAIRS AND NATIONAL DEFENSE DIVISION, CONGRESSIONAL RESEARCH SERVICE

Mr. PERL. I'll be very brief in my introduction of the panelists. Eric Rosenquist from the Department of State we've already introduced. Donor Lion was for three years the USAID Mission Director in Peru and he has also served as the AID Mission Director in Pakistan and Jamaica. Elena Alvarez is a Professor at the Center for Policy Research at the State University of New York. She has developed a project proposal on the economic and political economy of coca production in the Andes, implications for U.S. foreign policy and rural development in Bolivia and Peru. Peter Reuter is a senior economist with the Rand Corporation and also co-director of Rand's Drug Policy Research Center. And our commentator, Maureen Taft-Morales, is an Analyst in Latin American Affairs with the Congressional Research Service. Topics she covers are Peru and Latin American narcotics issues. And we will begin with Eric.

REMARKS OF ERIC ROSENQUIST, REGIONAL AFFAIRS OFFICER, DEPARTMENT OF STATE, BUREAU OF INTERNATIONAL NARCOTICS MATTERS

ERADICATION IS NOT JUST AN ENVIRONMENTAL ISSUE

Mr. ROSENQUIST. I'll just try to keep my comments brief because it is getting late in the day. I sort of digressed from what I thought I was going to make as a prepared statement, but I think one thing is emerging is it's quite true and why it's probably been difficult to structure today's workshop. You deal with biological and herbicidal

issues and right away the discussion very quickly moves into a discussion of the economics. And it is unfortunate in a way, and probably obvious why, the discussions tend to focus on one region in Peru which in some respects is typical but in many rather important respects is atypical. There are some unique conditions particularly as you are aware from the press regarding the activities in Upper Huallaga Valley. Some of the dire economic problems that Peru is facing that make that country not analogous to Bolivia or Colombia. And so we can't logically transform some raw conclusions that we reach here to other societies. But anyway, getting back to what I was going to make as an original premise. What is emerging is that you really have a situation of synergies. I personally am fairly convinced that if you just look at the issue in isolation as a purely environmental issue and isolate out all other factors that probably the herbicidal eradication of coca, although it would have some undesirable environmental effects, those undesirable environmental effects are far outweighed by the negative effects occurring because of coca cultivation as an issue in isolation.

ERADICATION IS AN ECONOMIC ISSUE

But this is not an issue in isolation; it's tied in with synergies that relate to military policy and breakdown of public order, at least in the case of Peru and the whole question of economic alternatives. We at the State Department, as a U.S. Government community, are aware of this and it is a fact that economic alternatives are going to have to be found at least in the case of Bolivia and Peru if sufficient pressure is going to be put on coca growers to abandon that crop in favor of some other commercial form of agriculture.

MOST COCA GROWERS ARE NOT TRAINED FARMERS

This won't solve all the problems because many of the growers—this would be particularly true in areas of Colombia and the Upper Huallaga Valley and not so true of Bolivia—are really agricultural proletarians. These are not people who are primarily agriculturalists. So consequently any economic package of assistance that is going to be found is going to have to take this fact into account. These people are not going to be able to be just transported to some other agricultural environment where they would be growing coffee or macadamia nuts and be expected to thrive, because they will not thrive. There are analogies elsewhere which demonstrate this. The two I can find right off the top of my head, one in Belize and one in Jamaica which I alluded to previously. Some of the cannabis growers were native farmers who just expanded this as a form of a cash crop, but many are urban proletarians who are brought into that region solely for one purpose and that is to be plantation workers. They cannot be expected to thrive if all other factors remain equal. So any kind of viable economic approach is going to have to take this situation into account.

MARKETS FOR ALTERNATIVE PRODUCTS ARE CRITICAL

There are indeed economic alternatives in terms of agricultural products, but then of course the problem has to be faced of market-

ing these products which means moving them from wherever they are grown to ports of embarkation and finding worldwide markets where these products would be viable. Sugar would probably not be a good choice, but sugar would be viable in many of the regions we're talking about. There is just not a sufficient worldwide market for sugar to make that desirable. And so common sense would tend to suggest those agricultural products which are going to be viable are ones which have high unit value and low transport cost—coffee, or certain high grade specialty coffees would be one, and macadamia nuts. Palm oil, which was grown in the Upper Huallaga Valley, is probably one from an economic point of view.

LACK OF PUBLIC SECURITY CHALLENGES VIABILITY OF CROP SUBSTITUTION PROGRAM

By the way, I should point that out that the reason that the production of palm oil was stopped in this area was not because of a lack of market. There is a large market in Peru and throughout South America for cooking oils and for soap products. The reason the production ceased is because of the endemic public security problems. Sendero simply have cut off the roads and attacked the trucks so there is no way of moving this product in and out. This whole problem is going to have to be addressed. You can't deal with the economic problems till you deal with the public security problem, which obviously requires increased levels of military assistance, so you have to deal with the whole synergy.

DEMAND MUST BE REDUCED

The other side of the issue is demand; it's unquestionable that unless demand is reduced in this country and in other consumer countries we're not the only kids on the block any more as far as being major drug consumers. The problem now has become endemic to most of the industrial world and endemic to many parts of the under-developed world. Unless the overall problem of demand is reduced, this problem in the worldwide sense is not going to change.

There is another underlying assumption that I think just has to be addressed in the last minute or so I have and that is there has been an assumption to do with the whole question that people are going to continue to grow and grow and grow and move out and out farther. The assumption is that there is a linear demand for this product, cocaine, which is really unfounded. The whole history of drug abuse in this country and in others which have had a long history of drug issue is not one of linear demand for drugs; it's a cyclical demand and it raises a chilling thought that after every major stimulant epidemic, and cocaine is effectively pharmacologically a stimulant, there has been a major epidemic of depressant narcotics use and this has certainly been the pattern in this country over the last 80 or 90 years.

Obviously these problems are synergies; yes, the problem of economic alternatives and foreign assistance has to be dealt with; this is not just a problem for the United States. The other countries of the industrial world which are also potential victims have to deal with this problem as well. This is one of our major diplomatic initiatives to try to draw other industrial countries into being willing

to assist the grower countries both in terms of access to markets and in terms of economic aid.

And yes, finally, demand is an issue in industrial countries, including the United States, which is going to have to be dealt with. It's a larger problem; the worldwide problem of demand for drugs is going to be dealt with because we have a big heroin and poppy problem that is looming out there now. And if the problems in controlling coca in the Andean countries look bad, they are nothing as compared with the problems of controlling poppy growth in countries such as Burma and Afghanistan which have no public order and are virtually under no governmental control whatsoever.

Mr. PERL. Eric, thank you for your remarks. Donor, you'll be given a chance to comment in the question-and-answer period. As moderator, I need to move along here otherwise we won't be able to get all the viewpoints expressed that we'd like to have expressed. Donor, could you comment briefly on the economic, political and social issues that you see here? You have had a lot of experience and also I'd be very interested in hearing what you see as options for policymakers.

REMARKS OF DR. DONOR M. LION, FORMER USAID MISSION DIRECTOR FOR PERU, PAKISTAN AND JAMAICA

Dr. LION. I'd like to assure everybody that the fact that Jamaica, Pakistan and Peru are among the largest sources of Marijuana, Opium Poppy and Coca had nothing to do with the fact that I served there. There was no cause and effect relationship.

LACK OF MEANINGFUL ECONOMIC DEVELOPMENT PROGRAM FOR THE ANDES

I'd like to make a series of assertions including some points that have already been made by many of the folks this morning. In spite of the claims in some quarters that we're winning the drug war and we're turning the corner, we all have been told today and we all know now that coca cultivation and production are growing in the Upper Huallaga and in Peru on the order of a 10 percent per year net increase. One of the reasons for this, in my opinion, and it has been alluded to a few times, is the absence of a meaningful and effective economic assistance and development program for the Andes. Coca production as we all know arises from many causes. One of the major causes is the failure to act on what I consider to be a fact, namely that poverty and underdevelopment combine to be a major reason for the relatively recent fantastic increase in coca production. Demand obviously is a major factor also and the two of them together, I suggest, are the major causes.

SECURITY PROBLEM MUST BE SOLVED BEFORE ERADICATION AND DEVELOPMENT CAN BEGIN

Again, a point made earlier this morning—adequate security in the coca-growing areas is a *sine qua non,* absolutely indispensable to success in the drug war. Effective eradication and substantial development activity simply cannot be undertaken unless the security problem is licked, and right now it is not. The most powerful force in the Upper Huallaga today is not the Peruvian government.

It is the Sendero Luminoso and the next most powerful force is the narcotraffickers.

NEED FOR MORE U.S. RESOURCES

Unfortunately, the United States has failed to provide or mobilize adequate resources for most of the components of a successful anti-narcotics program. I'm talking about interdiction, eradication and development. Between the executive branch and the Congress, less than 1 percent of ESF has been allocated to anti-narcotics efforts in the Andes. The Economic Support Fund is one of the two major funds that A.I.D. is asked to manage; development assistance is one, ESF is the other. ESF is usually related to political and strategic considerations of which of course drugs is one. I wonder whether 1 percent of ESF is a reflection of the priority that our rhetoric assigns to the drug war.

UNITED STATES NEEDS A REGIONAL STRATEGY

Our strategy during the 80s has been faulty. During this period, during this past decade the U.S. followed essentially a country-by-country strategy rather than a regional one, rather than a drug strategy for the Andes as a region. And even in this approach because of one reason or another, we focused on one valley, not the country of Peru. The fact is that half or more of the coca grown in Peru is grown outside the Upper Huallaga.

We have failed to exercise the initiative, the energy to mobilize international support and cooperation. The legislative branch has adopted unhelpful legislation and the executive branch has pursued a policy which caused performance in non-narcotics areas by producing countries to undermine prosecution of the drug war. If a country wasn't pursuing economic reform to our satisfaction, U.S. assistance wasn't forthcoming. Assistance would be limited or cut off for a while. If countries weren't paying their debts to the United States (for example, Peru owes the United States some money because of military credits made in the 60s), we could not make development assistance available to Peru.

ELEMENTS OF AN EFFECTIVE ECONOMIC ASSISTANCE AND REGIONAL DEVELOPMENT STRATEGY

An appropriate economic assistance and development strategy needs to do the following things. It obviously needs to provide incentives to farmers to abandon coca. It also needs to provide incentives to the thousands of nonfarmers whose survival depends on the coca economy. In fact, these people outnumber the legitimate farmers. An effective strategy also needs to provide assistance to the Andean governments which are now plagued by political terrorists, narcotraffickers, substantial unemployment and underemployment, massive fiscal deficits, inflation, and in Peru hyper-inflation, foreign exchange shortages and from time to time natural disasters in a disaster-prone region. This strategy needs to be phased, and this is terribly important, in harmony with the other components of an anti-narcotics program. You cannot go out there and only eradicate. Instant eradication is a prescription for violence, instability and failure because of the political opposition, the terror-

ist opposition, the farmers opposition, and the opposition of thousands of people who depend on coca. Interdiction, eradication and development have to be harmoniously interwoven.

We are, I'm afraid, delaying critical initiatives in economic and development assistance. Possible substantial increased assistance to the Andean countries as a group is being withheld until fiscal year 1991. This year, the amount of assistance to Peru is no more than it was the previous year and no more than it was the year before that: $12 million in economic and development assistance and $3 million in ESF for this fiscal year. This *de minimis* help is supposed to finance a development program we've been working on for several years not to mention a hope for increased anti-narcotics activities.

ERADICATION AND CROP SUBSTITUTION ALONE ARE NOT SOLUTIONS

A couple of quick comments. It has been said that there are more profitable crops than coca. To be true, this requires certain conditions which do not really exist. It requires a marketing infrastructure which doesn't exist. It requires physical infrastructure which doesn't exist. It requires a financial structure, credit, etc., which do not exist. Thus, the conditions do not exist for other crops which theoretically might have an attractive price. Another point to remember on the alternative crops issue is that only a modest proportion of the land now in coca is suitable for these other crops. Some is of course, but only a modest proportion. This is a phenomenon which really is troublesome. Next point. The price of coca can be manipulated. The margin of profit for the middle men, for the Colombian Mafia is tremendous and if other crops are potential threats, the price of coca will be raised to the farmer as has happened around the world. I was there when it happened in Pakistan with opium poppy when we would start making inroads on crop substitution and eradication. One conclusion to be drawn from this is that eradication and crop substitution alone do not make for a solution. They should be part of a holistic, integrated comprehensive strategy.

ERADICATION DOES NOT CAUSE INCREASES IN COCA PRODUCTION

It has been said that eradication is a fiction, it is not doable. It is also sometimes claimed that eradication is a major cause of the increase in coca production. I would like to make these points. Ten years ago, perhaps 15,000 hectares were in coca in Peru. My estimate when I was in Peru last year was some 250,000 hectares in all of Peru. Total eradication over the past decade may have come to 10,000 hectares. To attribute in any significant way the fantastic expansion of coca cultivation and production to eradication of 10,000 hectares scattered all over Peru (perhaps 5,000 hectares of it in the Upper Huallaga), is clearly not persuasive. The thousands of gold rush farmers who migrated to the Upper Huallaga did not do so because of the appeal of eradication.

I should point out that eradication efforts in the Andes have been sporadic and ineffective, partly because eradication was the focus. Our attitude was that it's a criminal thing; you excise it surgically and you maybe throw in a little aid. I would agree that

eradication as pursued in the past is not effective, but that doesn't mean we have to make the same mistakes in the future.

SUPPLY REDUCTION CANNOT BE NEGLECTED

Finally, on the demand-side issue. Clearly resolution of the demand side is the ultimate solution, but this aspect may take years, decades to resolve. Moreover, when we neglect the supply side or temporize with attacking it, we overlook the grievous and destructive impact of the narcotics industry on the producing countries. We tend to think only about the United States. What about the impact on the producing countries? And in addition, meaningful progress in reducing supply will raise prices. You can't have it simultaneously both ways; it cannot raise prices and also raise demand. It's a dynamic. The first impact of a price rise is to constrain demand and that's one of the things we're interested in doing.

REMARKS OF DR. ELENA ALVAREZ, ECONOMIST, STATE UNIVERSITY OF NEW YORK

COCA PLAYS AN IMPORTANT ROLE IN ANDEAN LIFE

Dr. ALVAREZ. I'm going to concentrate my remarks on some aspects of the agricultural economy of the Andes. This is the Andes of Peru with which I'm most familiar. My overall research project also includes Bolivia. I would like to talk about some of the socioeconomic and political reasons which explain the large expansion of the coca economy in Peru. Finally, I will discuss some policy options. Before doing that I would like to reiterate the cultural aspect of coca, the very important role which coca has had in the Andean life for thousands of years. Coca leaves are still chewed in many parts of the Andes, from southern Colombia, south to Bolivia and Argentina, and in the western part of the Amazonian basin. Coca is used as a mild stimulant and as sustenance for working under harsh environmental conditions. It is a household medicine and plays a crucial symbolic and religious role in Andean society. Total eradication of coca, therefore, would be affecting a substantial part of the Andean culture.

NEED TO UNDERSTAND DIFFERING PERUVIAN ECOLOGICAL AREAS

I think one important crucial variable which economists must understand is the difference ecological areas which you can find in Peru. There is the coast, and then there is the Andes, which is the backbone of Peru, and then the jungle. In the Andes there are several ecological areas, five to be precise, and every ecological area allows the production of different agricultural commodities. This is something anthropologists of course have known for many, many years, but we economists think that when agricultural prices change you can produce any commodity in any ecological zone. Peru is basically an urban country, 70 percent urban, 30 percent rural. Most of the Peruvian agricultural producers concentrate in the Andes. Two-thirds of the poorest agricultural producers are still in the Andes of Peru. These are the people who are going to migrate from the Andes to the jungle to produce coca for the pur-

pose of producing cocaine in the 1990s. Donor Lion has already emphasized the aspect of rural poverty in Peru. The Andean economy is indeed a very poor economy. The income per capita in the early 1970s for the Andean peasant was $50. In the mid-1980s the income per capita ranged between $152 to $620, which is still very low.

REASONS FOR EXPANSION OF COCA ECONOMY

Let us now discuss the reasons which, in my opinion, explain the expansion of the coca economy. Most of the agricultural policymaking in Peru, 30 or 40 years of policymaking, has been thought, planned in terms of urban industrial development. Actually, even the most important reform which took place in Peru, the 1969 agrarian reform which transferred the best lands, or about 10 million hectares of the 30 million hectares of Peru's farm properties, was thought and planned in terms of industrial development. This is urban bias policymaking and meant cheap foodstuffs for urban areas and lowered the profitability of the agricultural sector. Another important reason which, in my option, explains why such a large illegal activity thrives in a country like Peru is the weakness of the institutions and the legal economy. In terms of the benefits derived from coca, it is true that in the short- and medium-run, the illegal coca expansion is going to cause more poverty in Peru. Why do I say that? Let us just recall the discussion of the two previous panels this morning which emphasized the problems that coca imposes on the agricultural frontier. On one hand, it increases agricultural frontier since producers clear the forest in order to plant coca. On the other hand, coca decreases the agricultural frontier because of the negative effects on the soil and environment, and because coca leaches the nutrients of the land. That is, lands used for the production of coca cannot be used for anything else during several years. Even though these lands are not of the best quality, the point is that you cannot use them for any other purpose once coca is planted.

COCA ECONOMY CREATES POLITICAL PROBLEMS FOR PERU

Another aspect is that the illegal economy of coca is creating a very strong political problems for the country. You have two illegal activities which join together. One is the guerrilla movement, and the other one is the coca economy. The coca economy is financing the guerrilla movement, and the result is that these two forces are undermining the Peruvian state. If a price is determined on these things (ecological deterioration and political instability), I think these will worsen the country's economy in the long run.

PERU NEEDS DEVELOPMENT ASSISTANCE

In terms of options, I think there are very few options in the short run. It is well known that Peru is going through a very difficult economic situation right now—for instance, the hyperinflation on the order of 3,000 percent. The short-term economic problems must be solved first. However, for coca the only thing that the country can do—and it is of a long-run nature—is to rethink the rural development of Peru, and this is not just thinking about the jungle, the Upper Huallaga. Peruvians have to rethink the overall

agricultural development process. The issue of substitution is the issue of development. The problem of developing countries is one of finding markets for their products, and that is a major problem for most of the developing countries—how to sell textiles, coffee, and so on. The problem that is facing Peru in substituting coca is simply a problem of development. Since in the short run the country does not have the ability to generate foreign exchange, so the way is to appeal to the international community to give more assistance to Peru. I made calculations that this should be no more than $240 million a year during a five-year period. This is about $4,000 per family; if we consider 60,000 families affiliated directly with the coca trade it would be a very modest amount but could help the Peruvian economy right now. Thank you.

REMARKS OF DR. PETER REUTER, CO-DIRECTOR, DRUG RESEARCH CENTER, RAND CORPORATION

Dr. REUTER. I always hate being the last speaker on the last panel of a long morning. It is sort of like being the last skier on the slope at the end of the day and it's all been plowed. You just slide down and nothing interesting is going to happen.

ERADICATION PROGRAMS UNLIKELY TO RESTRICTLONG-TERM AVAILABILITY OF COCAINE TO THE UNITED STATES

What I would like to talk about is a framework that I think is useful for considering the consequences of different kinds of programs aimed at reducing production and export of elicit drugs from foreign countries. It's basically a framework which emphasizes risks and prices. What various kinds of supply side programs do apart from street enforcement is primarily raise the risks and other costs of producing, refining, and distributing drugs. That will be reflected in the margin that a particular producer, refiner, or distributor will charge to stay in the business. So a crop eradication program raises the risks and costs of farmers producing coca leaf and if you are able to increase those risks and costs enough, then more will have to be paid for coca leaf to induce the same number of farmers to put the same amount of effort and land into coca production.

This framework can also be used for thinking about interdiction. Interdiction is an effort to raise the risks and costs of smugglers and it should be reflected in the difference between the price at which smugglers sell their goods, the import price, and the price at which they buy it, the export price.

Let me go back to dealing with eradication. Eradication ought to raise leaf price if it's effectively carried out. Let's put aside for the moment the question of implementation. Assume we have an eradication program that imposes a one-in-three risk that a grower who continues to produce coca will in fact lose his crop; maybe there are some other penalties associated with that. Refiners will only be able to keep the current number of farmers in this activity if they are willing to pay more for the leaf. What are the consequences of that for consumption in the United States? Here I go back to a well known figure, which is that the price of the leaf that goes into cocaine is less than 1 percent of the retail price of cocaine. Major

changes in the prices that are paid to farmers to grow leaf have a negligible impact on consumption in the United States. That is why I find eradication programs very implausible as long-term prospects for restricting the availability of cocaine or any other drug in this country. It's not to say that such programs have no effects, just that less U.S. cocaine consumption is not likely to be one of them.

FARMERS ADAPT TO ERADICATION BY DISPENSING AND CONCEALING CROPS

Consider the adaptations that farmers make. Let's take the successful crop eradication program in Mexico in the mid-1970s, aimed primarily at opium, secondarily at marijuana farmers. There is no question but that in the mid-70s Mexican opium farmers were growing it in open fields; they were fat, happy, easy targets. They had never faced any serious risks before and the spraying was carried out relatively efficiently; new programs work better than older programs. As one observer commented the head of this program was a newcomer to government and he was in command of the largest Air Force in Central America. It felt pretty good and he in fact ran for a couple of years a very aggressive program. It had notable short-term impacts and medium-term impacts in the United States. But five years later, after a nasty production drop, farmers made the obvious adaptation. They moved to growing opium in smaller, less accessible, better camouflaged, more dispersed fields.

Presumably that made opium prices in Mexico go up; I don't have a price series that enables me to track that, but let's concede that the price of opium went up. Again, the question is how important is the price of opium at the farmgate in Mexico to the price of heroin in the United States. Again, opium accounts for a lot less than 10 percent—I think less than 5 percent of heroin's retail price. So even though we forced the farmers to more expensive and risky ways of growing, we ended up with levels of production which now I believe are quite comparable, if not greater than those during the mid-1970s.

I suggest to you that is the likely consequence over any period of time from an effective eradication program aimed at coca leaf. We will change the location and the geographic concentration of production, but we're not likely to have much more effect in terms of our own concerns.

ERADICATION CAN HAVE A SUBSTANTIAL EFFECT IN INDIVIDUAL SOURCE COUNTRIES, BUT NOT ON AVAILABILITY OF COCAINE IN THE UNITED STATES

We can have a substantial effect in the source countries themselves. In effect, we can take Bolivia out of the coca market. That is, if we mount an effective eradication program in Bolivia we can make Bolivian coca farmers the high cost producers and Colombian refiners will try to encourage more production in Peru. The Bolivian government has benefited if you believe that they want to reauce their coca growing, and the Peruvians presumably will have suffered if they would also like to reduce their coca growing. But I think that the primary effects of these programs are going to be

felt in the source countries and they are going to have very little consequence for the United States and on the basis that we share equally, I'll stop at that point.

Mr. PERL. Thank you for your comments Peter. Maureen.

REMARKS OF MAUREEN TAFT-MORALES, COMMENTATOR ANALYST IN LATIN AMERICAN AFFAIRS, CONGRESSIONAL RESEARCH SERVICE

NEED TO SUPPORT ANTI-NARCOTICS EFFORTS WITH ECONOMIC ASSISTANCE

Ms. TAFT-MORALES. I think there has been a general agreement here that economic and development assistance are needed to support the anti-narcotics efforts, and that the solution to the narcotics problem cannot be found in just a law enforcement strategy. I think there are conflicting ideas, however, about when that economic assistance and development aid should be given. Both Dr. Lion and Dr. Alvarez felt that it should be given immediately—or at least phased in together with anti-narcotics assistance, according to Dr. Lion. Although Mr. Rosenquist didn't spell it out—perhaps he could discuss it a little bit—the President's national drug control strategy, which was released just last month, says that economic aid is conditioned on drug control performance and the existence of sound economic policies in the host countries.

Although that sounds very logical and reasonable, these are no simple tasks for these countries to achieve under their current circumstances. I saw recently in a newspaper article where an American official in Peru described the situation in this way: he said, "Imagine you've got the Civil War and the Great Depression going on simultaneously, and then an outside country says you've got to take on Prohibition as well." So I think we have to ask whether these countries can carry out effective counter-narcotics programs without economic support and development programs already in place, and whether the United States should expect these countries to risk carrying out politically unpopular programs, such as eradication, with only the promise of a reward afterwards, and not incentives up front.

I think that in most cases it's not a lack of political will that keeps the Andean presidents from carrying out the kinds of policies the United States would like to see, but a need for them to deal with their own domestic situation and politics. They have other problems which they see as much bigger and more immediate, such as the economic crises and insurgency movements.

The coca farmers represent a sizable constituency in these countries, too. In both Bolivia and Peru coca farmers represent a bigger portion of the population than all kinds of farmers in the United States represent.

EFFECTIVENESS AND COSTS OF LAW ENFORCEMENT STRATEGY

At the same time there is also agreement here that there needs to be a variety of methods tried in fighting narcotics trafficking, and that interdiction and law enforcement measures do have some effect. I've heard more optimism lately than in any other panels

we've had, that law enforcement measures here had some effect. For example, Colombia's all-out attack against the cartels has led the traffickers to lie low and not buy coca. According to several press reports, the price of coca has plummeted from $100 per 100 pounds a year ago to $10 for the same amount right now. If such a drop in price were sustained, farmers would be dropping out of coca production out of simple profit motive.

But the question is, can that kind of attack be sustained? Is the assault on traffickers that is going on in Colombia a short-term strategy, until other, more long-term plans can be put into place, or is that going to have to be a long-term strategy as well? And if this assault on the traffickers is a long-term strategy, how much is that going to cost? How many years are we going to have to be involved in that? You also have to ask how long Colombia can sustain that kind of a battle, not just economically, in terms of the cost that it entails, but politically. How long will the Colombian public support the narcotics war when it has such high costs for their society? The murder rate in Medellin is 17 murders a day right now. When will the Colombian public start demanding that the government accept the narcotraffickers' offer of a surrender, and their offer to negotiate? And when will we start losing the Colombians' cooperation because of their own political pressures at home?

CONCERN OVER INVOLVEMENT OF ANDEAN MILITARIES IN COUNTER-NARCOTICS EFFORTS

I guess I was struck that no one on this panel mentioned the Andean countries' reluctance to involve their militaries in counter-narcotics efforts. One of the concerns that they have had is that the top officers in the military will be corrupted, and that it will increase the power of an often already powerful military, and undermine civilian authority. This is not an idle concern in these countries. In Bolivia, for example, in 1980, the Army seized power—backed by cocaine traffickers—and ruled for a year. And in Peru, in the late 1970s a trafficking organization had significant influence with the military government, and in 1985 another drug trafficking organization had significant control of the police forces. So I think the involvement, or the efforts to increase the involvement of the Andean militaries in counter-narcotics programs also has to be examined.

FUNDING OF COUNTER-NARCOTICS PROGRAMS

The final topic that I want to bring up, given our audience of congressional staffers, is that all the kinds of programs that are being discussed, the development programs, the alternative development, are very costly—where is this money going to come from? Staffers need to address what programs your Representative or Senator is willing to cut in order to contribute to the funding of these programs. Perhaps Mr. Rosenquist could discuss with us Administration efforts to coordinate some international programs and get other countries—Western European nations and Japan, for example—involved in anti-narcotics efforts and what kinds of projects the Administration sees coming out of those efforts.

DISCUSSION

Mr. PERL. Let's take a couple of questions from the floor first.

DEMAND REDUCTION IS CRITICAL

QUESTION. I'd like to just make an observation if I could. It seems to me that we're all in the United States heading a war on drugs, not a war on cocaine specifically. I think experience shows that if we eradicated every coca plant in the world tomorrow there would still be a drug problem here because people would start smoking or snorting or drinking something else and it seems to me that ultimately the only way that we're going to deal with the drug problem in the country is to deal with the demand.

ECONOMIC ASSISTANCE MUST BE LINKED TO ERADICATION

Mr. ROSENQUIST. Our basic viewpoint is that although it isn't questionable that assistance is required to make these programs work, I would say that from my own personal policy point of view that in terms of an earlier question, linkage is going to be required. The idea of just putting up foreign assistance without any kind of crop eradication goals is, I think, at least at the present time unthinkable. Some linkage between goals and eradication and enforcement in the source countries and foreign assistance are going to be tied together. That's just going to be a given. Our view as far as multi-lateral assistance, while this problem is largely ours, it is not exclusively ours. The other countries in the industrial world that are victims of the drug problem are users as well and this problem requires a multi-lateral approach. We have approached the G-7 and we will be next month in Houston, Texas. We are trying to start an initiative with some of the major European Community and non-Community members as far as getting pledges for assistance in the Andean countries. Japan has recently for the first time started to express interest in the large-scale economic development in the Andean region, although I think that the form and nature of that type of assistance needs to be worked out. But I think that is a very positive change in terms of the Japanese attitude on this and many other global issues. There has been a divergence from their typical or traditional attitude of wanting to remain aloof from most of these problems so I think there is hope on the horizon. I think it is going very slowly. And indeed in the case of Europe, Europeans have tended to regard heroin as the major drug problem, not cocaine, and therefore, maybe with the exception of the Spanish and to a lesser extent the Portuguese, have not been traditional players in the Western Hemisphere as a foreign policy power outside of the Caribbean, so therefore it is going to be a long haul to get them engaged, but I think it is important.

ECONOMIC ASSISTANCE TO ANDEAN REGION UNLIKELY TO IMPACT ON COCAINE AVAILABILITY IN THE UNITED STATES

Mr. PERL. Peter, I wanted to ask you a question before we take two questions. Do you think that any amount of economic assistance could markedly impact on the production of coca in the Andean region?

Dr. REUTER. I'm at heart a liberal so I always hate putting down economic assistance programs that give money to poor people, but the answer is I see very little prospect for the assistance having an impact on cocaine in this country. The reasoning uses exactly the same framework as for eradication. Think about what crop substitution programs do. They raise the value of the land and labor currently involved in coca growing. Coca refiners will now have to bid more to keep that land and labor in business but they can pass on the leaf price, since it has a small effect on foreign cocaine demand. They will be able to keep those resources in their industry. Coca farmers will be better off. Other peasant farmers down there will be better off, but let us have no illusions that we can somehow make growing carrots or whatever it is in Peru so attractive that cocaine refiners can't pay enough for coca leaf to induce roughly the current amount of land and labor to stay in this industry.

I cannot see a reason to put faith in economic assistance programs being effectively implemented over the next five years. Moreover, think about Mexico. We may regard it as a poor country, but compared to Bolivia, it's like West Germany; it's where Bolivia would like to be ten years from now and yet even there we still have very substantial resources involved in production of marijuana.

Dr. LION. I think what Peter is talking about is absolutely right. If you just think about crop substitution, you're not going to be effective. I am talking about and several of my colleagues have been talking about a new altered economy, a different kind of economic, social and political structure in the Upper Huallaga. We're talking not just about agriculture, we're talking about community development, we're talking about agricultural exports, we're talking about social services, health, education. We're talking about vocational training, we're talking about moving some of the people who are gold-rush farmers out of the Upper Huallaga. There are more gold-rush farmers there than there are legitimate farmers. We're talking about job placement. We're talking about changing the economy from a coca economy to some other type of economy. We're not just talking about crop substitution.

Dr. REUTER. Just briefly, I think that it is extraordinarily optimistic to believe that we can somehow restructure the economy of the Upper Huallaga Valley and ensure that there isn't displacement elsewhere. To believe that we can do that within the foreseeable future seems to me to defy the observations of experience. We have very limited capacities through foreign aid to make those major changes. I would love to be as optimistic, but I can't be.

WILL PRODUCTION SHIFT TO OTHER AREAS?

QUESTION. Continuing on the last comments made by Dr. Reuter and Dr. Lion, I pose this question probably to Mr. Rosenquist. What have we learned—maybe you could tell me in terms of a multilateral approach or a comprehensive type of aid package or economic development—what have we learned over the years that would keep us from repeating this situation that we had, the gentleman mentioned earlier Turkey, where we provide comprehensive

and economic assistance, economic incentives to remove the crop and it migrates to Pakistan.

Mr. ROSENQUIST. Well, I would dispute that's what happened in Turkey. Opium cultivation was traditional in Pakistan and the surrounding areas some period of time before the crop was removed in Turkey. The fact was the Turkish program was a very successful program that resulted in pressure on talking about problems from an American point of view, and reflected itself in pressure upon the street prices of heroin in this country and apparently reduced heroin addiction permanently.

Mr. PERL. What about the concept of shifting production? I think the question was not so much what happened in Pakistan, but what might happen in the Andes.

Mr. ROSENQUIST. Initially the production in Pakistan and in Afghanistan really did not feed the American market; it fed the Iranian market. No, I don't think so. There has been some movement in Brazil, but there are some real problems with Brazil and it was alluded to earlier. The quality of the coca grown in Brazil is of a very low order. It's not an adequate replacement from a refiner's point of view and I think there is something that underlies this whole discussion that hasn't really been brought out. There are some major differences between opium production and cannabis production and coca. The amount of biomass you need to produce a kilo of cocaine is very, very high, on the order of 150 to 200 kilos of leaf for one kilo of coca. So the question of the quality of yield to the leaf is of paramount importance and the quality of the leaf in both Brazil and the lowlands of Colombia has been very low and, although there has been some marginal increase especially in the areas around the Bolivian border where traffickers have recruited local indians to grow coca, it's still not anywhere in the order of magnitude and I think it's unlikely to be. There are other reasons it's unlikely to be, political reasons. The government of Brazil maintains strong forces for public security. You do not have an analogous situation of breakdown of law and order in Brazil that you have in some of the surrounding neighbors. So I think it is unlikely that you are going to see wholesale expansion.

DANGER THAT GENETIC ENGINEERING MIGHT BE USED TO PRODUCE MORE POTENT COCA IF ERADICATION MAKES GROWING AREA AN IMPORTANT COST FACTOR

Dr. REUTER. Could I just pick up the point of the biomass required for coca production and for cocaine production? Under current conditions farmers have had no incentive to move to high yielding strains or to make any kinds of adaptations that would lead to higher potency, i.e., higher alkaloid yields. Think about our experience with marijuana where over time, as bulk became a critical sort of cost factor because there was substantial risk of having smuggled quantities seized. This led to a shift to much higher potency marijuana. I believe that we have to pay some attention to the possibility that through genetic innovation, there would be a substantial improvement in the yield of coca if we made growing area an important cost factor because of eradication efforts.

DRUG PROBLEM IS REGIONAL AND CARTEGENA SUMMIT SHOULD TREAT IT ACCORDINGLY

COMMENT. We all know that we are on the eve of the summit. I think it would be helpful for all of us to have this panel, which is a pretty powerful panel, and sort of look at your crystal ball and first of all tell us (and especially it may help one of the staffers today) what do you think the summit is going to say and secondly what do you think the summit ought to say about the problem in not only Peru but the entire Andes?

Dr. ALVAREZ. May I make some comment regarding foreign aid? I just came back from Peru and one fact that made me think in terms of foreign aid was the low price of the coca leaf right now. It's below the price of the legal coca, the coca purchased by the state. It is true that this is something that usually happens after interdiction; it happened in Bolivia before. But if the conflict in Colombia between the government and the traffickers persists, I wouldn't be surprised that gradually the coca production for export would move to another country. It would be a displacement effect. The former coca producers would need assistance to produce something else. The other thing is that I am doing research on coca production and reading all the reports that are available in terms of production. Marc Dourojeanni asked this morning about the hectares actually planted with coca in Peru. I have found only one study, conducted by the United Nations Development Programme (UNDP) on the Upper Huallaga Valley and in which for the first time I have seen a rigorous explanation about how the number of hectares were determined. I have seen 300,000 and 150,000—many people use 200,000 hectares in Peru.

There are no justifications for these numbers. However, the UNDP, using aerial photography, labor availability, land-use potential and key input requirements, estimate a figure no larger than 100,000 hectares in the Upper Huallaga Valley. I raise the issue of foreign aid because it is something that is needed by Peru. It will not solve the problems of Peru altogether because the process of development is not something that depends on just foreign aid. It never has depended on foreign aid, but I think it is something needed by Peru now. In terms of what would I expect to see coming out of the summit, I would like to see the illegal drug issue to be considered a regional problem. There are producing countries, Peru, Bolivia, Colombia, but there are other countries which are also involved. I understand that Colombian traffickers are buying pieces of Ecuador, literally. Part of the production is moving to Brazil; they use Argentina and the Caribbean as transient points. This is not a problem just for Peru, Bolivia, and Colombia. This is a regional problem and I wish they would consider it like that. A sort of new "Alliance for Progress" for the coca issue.

ANDEAN NATIONS NEED IMMEDIATE ECONOMIC ASSISTANCE AND LONGER TERM FUNDING COMMITMENTS

Dr. LION. I think we're all familiar with the fact that our President has a penchant for dropping surprises and I'm hoping that he drops a very big one along with his colleagues at the Summit in Colombia this Sunday. However, one must be, or at least I am,

somewhat pessimistic. If we continue the mistakes of the past by withholding front money, some support, some transition assistance, some start-up assistance pending performance in a country or countries where there is a major internal insurgency and a massive depression, we will continue to fail. So what I would like to see coming up is a change in that approach. Performance and assistance should be linked but over a several-years period to provide the incentives and the necessary support to get started. That requires front money and a commitment to provide certain amounts over periods of time for certain programs if there is continued collaboration by the host country. I might say one other thing on the question of the price of coca. Basically, that's not what's critical. What is critical is the relative price of coca. If other commodities are even lower priced to the farmer, then he has to make a choice as to what he is going to do and even if the price of coca drops from $100 to $10 at the farmgate, if he can get more for coca than he can for potatoes, which he can still do at $10, he may continue to grow coca.

PERHAPS THE UNITED STATES AND THE ANDEAN NATIONS SHOULD NOT BE LINKED TO NARCOTICS PREFERENCE OBJECTIVES

Dr. REUTER. I think of myself as a policy analyst. I tell people what I think are the consequences of their decisions, which means I hate having to state my own preferences. I think that the summit will probably be a good news summit. That is, Mr. Bush will announce that relatively large sums of money will be available to the source countries. The source countries will announce that they are indeed trying to deal with this problem more resolutely, with more commitment of enforcement resources as well as economic aid. A better outcome, which is politically entirely infeasible in the current climate, would be that Mr. Bush goes down, shakes hands, says, "Here's money because we have in fact, through our inability to control demand, contributed substantially to the problems that you have. But we understand that these are problems we solve inside our own borders and do call us again when we can be of help."

PRESSURE ON EUROPEANS TO PROVIDE NARCOTICS-RELATED ASSISTANCE WILL INCREASE

Mr. ROSENQUIST. I agree with at least the first part of Dr. Reuter's statement. I think there will be some increased assistance; I think it's one thing that will come out of the summit. I think the other thing that is almost certain to come out, because there will be European representation, will be increased pressure on the Europeans to make foreign assistance commitments, at least some of which will be forthcoming out of the summit. Maybe not the level we would like but I think there will be an increased commitment from them.

Mr. PERL. Eric, because you were the only panelist who was on two panels rather than one, I've been a little harsh with you in terms of time limitations. Is there anything that you feel that you should say or would want to say or that's been important that's been left out?

NARCOTICS PROBLEM WILL DECREASE FOR UNITED STATES, BUT MAY THREATEN SECURITY OF OTHER NATIONS

Mr. ROSENQUIST. No, I think it's all been said and been said many times. I think the issue is a synergistic one. It would be wrong to consider the issue of eradication or public security or foreign assistance and isolation from the other issues; these are all integrated. It is quite right that in our outlook we naturally look to the interest of the United States first. That's what foreign policy is all about. But, there are some sound reasons for controlling the spread, the growth of coca and for that matter any other illicit crop elsewhere in the world. Sound foreign policy and security reasons transcend what happens in this country and what doesn't happen in this country in terms of drug abuse. We have foreign policy interest in a secure world. We certainly do not want to see other countries, and particularly our neighbors in this hemisphere, disintegrate into chaos or anarchy, which can happen. There are many compelling foreign policy reasons to go beyond just merely the question of a control of illicit narcotics that should make us interested in this problem. I do find one. There has been one underlying economic assumption now that I don't think is borne out by any impure or epidemiological evidence that I know about drug abuse. There is sort of an underlying assumption that the demand for cocaine is unlimited, and so therefore there is a linearity that is telling us that the people always will grow more and more and more if pressure is put upon them. And this isn't borne out by facts. In fact, if drug abuse is cyclical, and I think the evidence suggests even now that we're probably on the downward slope of the cocaine problems, despite the epidemic of crack use, that probably 15 years from now if we are seated here we will probably be talking about something else as problem number one.

Mr. PERL. This concludes the seminar. I wanted to thank our panelists, our participants, and also the people who handled the sound. I think they've done a really fantastic job. I've been in many committee hearings where the sound has not even been comparable to what we've had here and I think it's a real art form; they've done a great job. Thank you. We do have a list; we will send you the publication unless you don't want it. If you don't want the committee print let me know.

APPENDIX I

NEEDED: AN EFFECTIVE U.S. ANTI-DRUG STRATEGY IN THE ANDES

(by Dr. Donor M. Lion, Career Minister, U.S. Foreign Service, Retired)

The anti-drug summit in Colombia, where the economic and social aspects of coca production were recognized, represented a symbolic advance in the drug war. The Latin American presidents were pleased with this aspect of the meeting. For the United States, however, the summit, substantively, represented little bold or new. It reaffirmed the strategy laid out by the administration in September of last year. That strategy gives highest priority to enforcement and inadequate attention to the root causes of coca cultivation and production. With increases in economic assistance to the Andean countries delayed until fiscal year 1991, with an approach that does not appear to involve Ecuador fully, and with insufficient attention to the need for major economic and development initiatives to replace the coca economy, it is doubtful that we are pursuing an effective strategy.

WE MAY BE LOSING THE DRUG WAR IN THE ANDES

The cultivation and production of coca are increasing in the Andes. Although not a definitive index of how well or badly the drug war is going, this is a disturbing and dangerous phenomenon. Moreover, the battlefield is spreading beyond the big three, Bolivia, Colombia and Peru. Ecuador has emerged as a player—not, currently, as a producer, but as a money-launderer and major transhipper of precursor chemicals and cocaine. Brazil is in the wings as a potentially significant supplier.

THE ECONOMIC DEVELOPMENT COMPONENT OF AN ANTI-DRUG ANDEAN STRATEGY HAS BEEN SHORTCHANGED

The necessary components of a comprehensive anti-drug attack in the Andes are well known—interdiction, eradication, public awareness and economic development. But they are not all being effectively pursued. In Peru, eradication has ceased. Development activities are ineffective. These last two elements are of course directly related. All of us who have been involved in the anti-drug battle in the field have lived with the truth—there is little or no incentive for the campesino to give up coca if the alternative is starvation, sick and dying children, and threats from terrorists. There is little or no incentive for the thousands of others, non-farmers, whose livelihoods are dependent upon a coca economy. And, at best, incentives are mixed for impoverished governments

with insufficient and declining foreign exchange when coca is their largest single source of hard currency.

Without an alternative economy in the coca growing regions, coca eradication is a prescription for increased violence and an even stronger terrorist threat to fragile democracies, not to mention life-threatening economic misery. It is no wonder that eradication activity has been halted in Peru.

COCA PRODUCTION REFLECTS DEEP-SEATED UNDERDEVELOPMENT

The "legitimate" farmer growing coca, the "gold-rush" farmers and the thousands of others who are surviving because of the coca economy are a manifestation of many forces, including consumer demand for cocaine and its derivatives, poor agricultural policy, promotion and support by narco-traffickers, corruption, pressure from terrorists. Also critical are the generations, even centuries of poverty, injustice and abandonment in the Andes. The word "underdeveloped" is a sterile euphemism for this human tragedy. Accordingly, the attack on coca cultivation and production should proceed with a commitment to long-term development activity—by the producing countries themselves and by their better off friends.

U.S. INTERESTS ARE SERVED BY DEVELOPMENT PROGRESS IN THE ANDES

The anti-drug war alone is sufficient to justify economic and development assistance to those in a strategic position to help us fight it. In the Andes, such assistance also makes sense for other reasons. Bolivia and Peru are South America's poorest countries; they are struggling democracies and Colombia is not without a serious threat to its political system. Bolivia and Peru's economies are in desperate shape, not only addicted or virtually addicted to coca, but with mass unemployment, underemployment, and in Peru's case, hyperinflation. National institutions, systems, and infrastructures are weak. Drugs aside, the United States has strong political, economic, security, human rights and humanitarian interests and objectives in the Andes which would be served by economic and development assistance. It is evident that the development component of an Andean anti-drug effort is an enlightened form of U.S. self help. Such a component should also reflect the nature of the Andean crisis, of which narcotics is both a reflection and a cause.

OBSTACLES TO AN EFFECTIVE ANTI-DRUG PROGRAM IN THE ANDES

Security

The security problems in Colombia and Peru are clearly an obstacle to anti-drug efforts. In Peru's Upper Huallaga, the major coca-growing valley in the world, the control exercised by the "Sendero Luminoso" (Shining Path) guerrillas and the violence of narco-terrorists preclude a successful anti-narcotics program. An effective development program simply cannot be undertaken in current security circumstances. Management of the security problem in Peru and elsewhere in the Andes is a *sine que non* for success in the drug war.

Insufficient Resources

To date, resources mobilized to fight the drug war in the Andes have been grossly insufficient. Bolivia and Peru are impoverished and in deep trouble. They are unable to cope with their social, economic and development problems, not to mention taking on the narcotraffickers and in Peru's case, both the narcotraffickers and the "Sendero Luminoso" and other terrorists. Colombia, although in better shape, needs help. The United States has, until now, treated narcotics in the Andes largely as a criminal problem and has failed to make available the economic and development assistance resources required to deal with a major cause of coca production, namely poverty and underdevelopment. The international community, similarly, has not come forth with meaningful development help.

Faulty Strategy

Our Andean anti-narcotics strategy has been less than optimum. Although the battle has been waged for years, it was not until September, 1989 that the U.S. defined the problem in regional terms—and that in response to the Congress' call for a regional plan. During the 1980's, we largely dealt with narcotics in the Andes on a country-by-country basis. The level of resources we directed against the supply side was determined primarily by non-narcotics considerations. Criteria such as the level of economic reform and the countries' stance on selected foreign policy issues were more important in fixing U.S. anti-narcotics assistance levels than the Andean narcotics problem itself. Even the country-by-country strategy was not fully pursued. In Peru, half or more of coca was and is produced outside the Upper Huallaga. Nevertheless, we limited our cooperation and support, in effect, to one valley, the Upper Huallaga. The one valley-at-a-time strategy is likely to cost more in the long run and to make more complicated the task of eradicating coca production. A strategy which gave full weight to the social, economic and underdevelopment causes of coca production throughout Peru would have generated a more effective anti-narcotics program in that country.

Inadequate International Cooperation

On the financial side, international cooperation and support were inadequate. International cooperation has been characterized by meetings, good intentions, impressive rhetoric and assorted agreements on goals. The international stake in the war against narcotics has been thoroughly understood and articulated. But in terms of delivered action to the producing countries, the problem has not been accorded real priority.

Unhelpful Legislation

The Congress laid on sanctions and certification legislation which either required the producing countries to attempt to do more than was feasible (for financial, security and other reasons) or required the executive branch to stretch the truth in order to continue a modicum of assistance. In one way or another, the Congress and the executive branch have tied assistance in the drug war to non-

narcotics objectives, such as economic policy performance or the status of debt repayments to the United States.

GUIDELINES FOR AN ANDEAN ANTI-DRUG STRATEGY

From the foregoing, the following guidelines for an effective strategy can be drawn. Many of these have been set forth elsewhere, including the Congressional Research Service's recent seminar on the "Andean Drug Strategy and the Role of the U.S. Military."

Mobilize Adequate Resources

An effective strategy requires more resources than the producing countries can possibly afford and the U.S. and others have made available. This is particularly true for the economic, development and security elements of an over-all strategy.

Gain Control of Coca Areas

Without government control of coca production areas, no large scale anti-narcotics effort, including its development component, can be undertaken.

Pursue Development

Coca production is not simply a response to U.S. and world-wide demand for drugs. It is also directly related to a lack of development, to generations of economic, political and social injustice, and to past and in some cases current ill-advised economic and social policies. This means that although it is impossible to take on all the problems of these countries, a focus on coca, as complex as that is, needs to be accompanied by efforts to strengthen democracy, foster human rights, and promote economic development and sensible economic policies.

Design a Regional Strategy

All the Andean countries including Ecuador should be covered. Development, interdiction and eradication measures need to be designed and executed in a regional Andean context. Economic assistance should be shaped to reflect regional requirements. Regional (e.g., Andean Pact) institutions should be drawn into the struggle.

Develop a Coherent, Comprehensive Strategy

The strategy should be coherent in the sense that non-narcotics objectives should not be allowed to undercut anti-narcotics goals. Success in the drug war is too important to allow, for example, shortfalls in economic policy performance to subvert anti-drug achievements. The strategy needs to be balanced and complete in at least two respects: it should encompass all elements required to achieve objectives and it should engage all the agencies, tools and resources at our disposal—the Department of State, A.I.D., DEA, USIS, EX-IM, OPIC, Departments of Defense, Commerce and Agriculture—and should involve new policy initiatives in economic and food assistance and in trade, investment and LDC debt areas. The executive and legislative branches should modify their current approach to sanctions, Andean debt arrearages, assistance levels and

funding earmarks. Less than one per cent of ESF is traditionally earmarked for support of anti-narcotics efforts in the Andes. Is this allocation a reflection of the priority our government and our citizens attach to the drug war?

Mobilize International Support

The bill is a big one. But it is one which the United States and the producing countries cannot and should not bear alone. With cocaine and crack markets expanding more rapidly in Europe, perhaps now is the time for more active U.S. leadership in mobilizing international financial, technical and institutional resources.

AN ECONOMIC ASSISTANCE AND DEVELOPMENT STRATEGY

A meaningful on-going economic assistance and development program will provide incentives to dismantle the coca economy. A viable alternative to this economy would make possible legitimate continuing sources of income and employment to those whose livelihoods and survival depended upon coca. It is evident that the economic problems in coca growing areas is not simply an agricultural problem, looking for crop substitution as the solution. Dealing only with the farmer does not confront the need to restructure and rehabilitate the coca economy. The political and social problems in the coca-growing areas erode motivation, weaken central and local government influence, build opposition and strengthen the hand of political terrorists and narcotraffickers. They should be dealt with—primarily through integrated area development programs. Further, the political will of governments which basically wish to cooperate—as do the Andean countries—needs to be supported and reinforced, given their economic distress, financial plight and the prospective losses of hundreds of millions of dollars in foreign exchange which a successful eradication program would assure. It is apparent that without something to replace the coca economy, effective coca eradication would have grave if not catastrophic social, political and economic consequences. Instant eradication is, of course, infeasible. But even if possible, it would be imprudent. Moreover, economic and development activities take time to carry out and to bear fruit. Accordingly, these activities should be carefully timed, phased and synchronized with other anti-narcotics efforts, especially eradication.

The foregoing considerations are reflected in the following outline of an economic assistance and development strategy. Two major phases or components are involved: first, economic support, start-up and transition; second, area redevelopment. Phase one would include economic support to the Andean countries to mitigate the negative effects of foreign exchange losses from net coca eradication in the form, for example, of a multilaterally financed regional foreign exchange fund. The dollars disbursed from this fund could generate local currency which could finance other anti-narcotics activities. A second element of this phase would be budget support to the Andean government's anti-narcotics and development entities, all of which are financially strapped—the police, military, federal and local agencies. Financing could come,

at least in part, from the local currency generated by the foreign exchange fund.

Phase one would also include financing of commodity imports and technical assistance—fertilizer, pesticides, seeds, equipment, spare parts, fuel, etc. The transition element of Phase one would encompass food aid, medicines and other supplies, and credit.

Phase two involves an area development program to replace the coca economy. Such a program would include agricultural development, community development, infrastructure investment, agribusiness and agricultural exports, vocational training for off-farm employment, job creation and placement outside the coca area, social services, institutional and public administration strengthening, credit and market development, and the recovery of coca-damaged soils and reforestation.

This economic assistance and development strategy would cost on the order of one billion dollars over some five years. The portion financed by the United States would depend on the contributions mobilized from the international community.

* * * * * * *

We have lost years in the war against cocaine in the Andes. In the meantime, this illicit drug trade has become the fastest growing, most profitable industry in the world, a truly multinational industry and an integral part of the international economic system. The U.S. Andean strategy, announced last September, includes useful measures but envisages further delays in mounting needed initiatives in economic and development assistance. For example, current Development Assistance and Economic Support Fund levels to Peru are no higher than they have been for several years. Possible increased assistance is to be held off until fiscal year 1991. It is reasonable to question the wisdom of this approach, and to be concerned about the human cost, here and elsewhere, which this policy entails.

APPENDIX II

THE AGRONOMICS OF COCA (ERYTHROXYLUM SPECIES)

(by Dr. Joseph Antognini, Research Leader, Tropical Plants Laboratory, U.S. Department of Agriculture)

E. coca and E. nova are the major species grown for the production of alkaloids (cocaine). These are perennial plants which are produced from seed. The time required from seeding to first harvest is 18 to 24 months. Thereafter, harvest, stripping of leaves, occurs every 2 to 3 months with the life of the plant being 10 to 15 years. In contrast with *Erythroxylum* species, marijuana and opium poppy are annuals reproduced from seed. For these crops seeding to harvest is 3 to 5 months for marijuana, and 4 to 6 months for poppy.

A second major difference between the perennial (*Erythroxylum*) and the annuals (poppy and marijuana) is that *Erythroxylum* has a relatively narrow geographic area in which it can be commercially grown. It has become adapted over thousands of years to a tropical high altitude (1500 feet to 3600 feet) environment and suffers severe damage when the temperature falls to 55 degrees Fahrenheit. On the other hand, opium poppy and marijuana can be grown over a wide range of temperature and tropical conditions, and since they are short-season annuals, three crops per year can be produced in many locations. This also means that within a country, they can be grown 12 months of the year, facilitating rapid breeding and other types of research.

The above differences must be seriously considered whenever one attempts to compare the perennials to the annuals. These considerations will have significant impacts on conclusions and decisions. For example, an eradication program of marijuana could result in no reduction in production because growers immediately reseeded and only ended up delaying their harvest for a few months. Based on such results, one cannot conclude that the same would happen with coca. It takes 18 to 24 months from seed to harvest of coca, which raises two questions. First, what is the grower going to survive on for 18 to 24 months, and secondly, would he gamble potential income in 24 months against crop destruction against crop destruction again in 18 to 24 months? In other words, one should not conclude that such-and-such will not work on or with coca because it did or did not work on marijuana poppy in country or in situation A or B.

APPENDIX III

REASONS FOR THE EXPANSION OF COCA EXPORTS IN PERU

(by Dr. Elena Alvarez, Associate Research Professor, University Center for Policy Research, State University of New York at Albany, Milne 300; Albany, NY 12222)

I. Introduction

The coca plant is an important part of the Andean culture, and it is probably the single most profitable export crop from the Andes of Peru and Bolivia. For the Andean region, whose backward economy can be, and often is, equated with those of the least developed countries in Asia and Africa, the coca expansion should be a welcomed fact. However, because of its alkaloid content, the coca leaf is the basic raw material for the manufacture of cocaine, an addictive substance whose illegal distribution in most countries has assumed alarming proportions.

A type of cocaine hydrochloride is usually the form which is sold in the illicit traffic. The process of production starts with crude cocaine or coca paste, a mixture of alkaloids that is about two-thirds cocaine. Coca paste is later converted into a salt by solution in hydrochloric acid and further treatment to remove the other alkaloids. Peru and Bolivia have been exporting coca paste to Colombia and other countries, where the paste was processed. However, there is growing evidence that Bolivia and Peru are directly exporting cocaine.

Although the price of coca leaf has decreased recently at a level below the coca leaf sold in the legal market,[1] a recent study of the coca economy in the Upper Huallaga valley reports, using December 1988 data, that profitability of coca may range between 2.4 times that of cocoa and 39.9 times that of yellow corn [Tantahuilca (1989)]. An earlier report [Desco (1988:47)] indicates that farmers in the same area could obtain $4,500 a year per hectare producing coca whereas in the next most profitable legal crop (cocoa) thus could only earn a maximum of $600.

Given the difficulties in obtaining (or producing) data on the coca economy, the following estimates are naturally subject to a very

[1] Interview with officials of the National Enterprise for Coca Marketing (ENACO), Lima, January 22, 1990. Since September 1990, after the beginning of the open war between the government of Colombia and the drug traffickers, the price of the coca leaf in the illegal markets has fallen drastically, a situation which continues right now. Interdiction measures in Bolivia in 1988 seemed to have had similar impact on prices in Bolivia, but were of temporary nature. However, given that the core of the cocaine industry is located in Colombia, it is not clear how the new restructuring of the industry will affect the future of the other producing countries, in particular Peru and Bolivia. The price of coca leaf has also declined in Bolivia (New York Times, May 20, 1990), pp. A1 and A12).

substantial margin of error. They are helpful, however, in providing impressions of the magnitudes involved. Coca paste may have produced between 13 and 34 percent [or $356 million to $895 million, Alvarez (1990)] of the total (legal) export proceeds in 1988 for Peru. This is between 3 and 8 times the amounts that coffee, the most important Peruvian legal agricultural export, generated in export earnings during the same period. Also, between 1 and 3 percent of the Gross Domestic Product (GDP) in Peru were associated with the illegal coca activity in 1988. Furthermore, these estimates indicate that this activity is one of the largest employers in the country: between 3 and 5 percent of the total employment in Peru is directly and indirectly related to the coca activity—or about 7 to 12 percent of the agricultural employment (Ibid.).

The purpose of this paper is to outline (a) some of the socio-economic and ecological conditions which may help explain the illegal coca expansion in the Andes of Peru, (b) some of the major possible socio-economic and political consequences which this activity may have had on this country, and (c) briefly discuss some of the alternatives.

The paper has been divided into five sections. In the next section a brief background on the Peruvian agricultural economy and coca production is presented; in the third section, a discussion of the reasons behind the coca expansion in Peru is presented. In the fourth section, the possible consequences of the coca underground economy in Peru are discussed. Finally, some alternatives are discussed as concluding remarks.

II. Background

on coca

The coca leaf has been part of Andean life for thousands of years [Mortimer (1901), Morner (1985)].[2] Coca leaves are still chewed today in many parts of the Andes, from Southern Colombia, south to Bolivia and Argentina, and in the Western part of the Amazon Basin. The largest share of the coca output is produced for external markets in Peru and Bolivia.

Coca leaves have been used and are still used as a mild stimulant and as sustenance for working under harsh environmental conditions [Murra (1986), Morner (1985)]. They are also used as a household medicine for diverse medical complaints, and play a crucial symbolic and religious role in Andean society.

As reported by Plowman (1980; 1986), the coca leaf, a perennial shrub, belongs to the genus *Erythroxylum* which includes about 250 species, most of which occur in the New World tropics. Two species and four varieties have been identified. All cultivated coca, however, derives from the two species.

Distinguishing varieties is crucial because they seem to have an impact on the conditions of production and profits. This is the case because different varieties require somewhat different ecological

[2] It certainly preceded the Incan empire as indicated by historical studies [Rostorowski de Diez Canseco (1988)].

settings, have different yields, or present various degrees of difficulty in extracting the alkaloid.[3]

The "Huánuco" (or "Bolivian") coca is the principal commercial source of coca leaves and of most of the world's cocaine supply. This is a shrub one to three meters tall and grows mainly between 500 and 1500 meters of elevation, although it may be found up to 2000 meters in some areas (Ibid.).[4] Geographically, the production of this variety extends from Ecuador south to Bolivia. It is unknown in Colombia and in the Amazonian lowlands (Ibid.:12).

The Bolivian Chapare and the Peruvian upper Huallaga Valley areas, in which the expansion of coca production for exporting have mainly occurred in the last decade, seem to be the perfect habitat for the Huánuco variety. It also seems to be the perfect commodity to be produced in these areas. In fact, production can be started after two and even one-and-a-half year from cultivation; leaves can be harvested between four to five times a year, and even six times if better agricultural techniques are utilized. It can survive up to twenty years with little use of fertilizer and with proper weeding, and can maintain relatively good production levels in lands of poor quality [Peña (1987)].

COCA PRODUCTION

Given the illegal nature of the crop, it is very difficult to determine accurate production figures. The quantity produced has been estimated on the basis of aerial photographs of the known producing areas, which gives an approximate number of hectares devoted to the crop and to which an imputed yield is applied. Yields seem to fluctuate between less than one and over two metric tons per hectare per year depending on the age of the plant, altitude, variety of the plant, conditions of production and many other factors.

Data obtained in the producing countries and those estimated in the United States after interdiction of illegal shipments are often difficult to reconcile. Numerous reports seem to indicate that, given the information available, the U.S. market would appear to be permanently oversupplied [Reuter et al. (1988)].

Although there are more official estimates of the illegal production, official statistics in Peru are from data collected from the legal production of the crop and, therefore, account for a very small fraction of total production. Although a growing portion of the legal production has been going to the illegal market,[5] the

---

[3] The four varieties are Huánuco, Ipadu, Trujillo and Colombian. The *Huánuco (after the name of the Peruvian department where it was most prevalent)—is also available in Bolivia, Ecuador, Argentina—and the Ipadu* (or Amazonian, cultivated in Brazil) are the most suitable for commercial purposes. The *Trujillo* (Truxillense named after the town in northern Peru near which this variety was initially found; it is cultivated also in Ecuador) and the *Colombian* (or Novogratense from Nueva Granada, the colonial name of Colombia) are not commercially popular given the difficulties in the extraction of the alkaloid. This last variety is said to have been used as a flavoring for the Coca Cola drink.

[4] All of the American species of the genus are shrubs or small trees. They grow usually in the understory of primary and secondary forests, or in open thickets. The wild species occur mainly below 1000 meters of elevation, though the cultivated forms may grow as high as 2000 meters [Plowman (1980:91)]. Plowman and other experts seem to agree that the higher the altitude where coca is planted the better its quality.

[5] Interview with Chief Industrial Manager, ENACO, Lima. According to the ENACO information on hectares legally planted with coca leaf, ENACO only purchased a fraction of the coca leaf planted in the legal areas, about 25% of the production in 1989 [4,500 tm; if yields are as-

Continued

legal production in Peru is supposed to be purchased entirely by the National Enterprise of Coca (ENACO) which buys coca leaf from duly registered coca producers at a price which was usually a fraction of the price in the illegal market.

ENACO sells coca leaf directly to consumers, produces several industrialized coca by-products (e.g., coca tea bags), and manufactures cocaine hydrochlorine to be exported for pharmaceutical purposes.

Many of the recent papers on the coca economy in Peru discuss the correct range in which planted hectares and production of coca by-products may fall [See Alvarez (1990) for a discussion of this literature]. The quality of the methodological procedures used to do this is very heterogeneous. The estimates range between 26,000 ha. for the Upper Huallaga Valley-UHV (Peña) and 380,000 ha for the whole country (a figure quoted to the press by a former minister).[6] According to Dourojeanni (1989) the "most likely" figure for the whole country must be around 200,000 ha. This may well be the case as we have estimated elsewhere [Alvarez (1990)].

Most of the studies have concentrated on the Upper Huallaga Valley where most of the illegal coca expansion is believed to have occurred in the 1970s and 1980s. Although the empirical evidence is not clear, recent estimates seem to indicate that the illegal expansion in other areas of the country is as large or even more significant than in the UHV [Laity (1989)].

AGRICULTURAL SETTING

Based on geography and climate, Peru may be divided into three distinct regions: (1) the coast, a desert strip located between the Pacific Ocean and the Andes; (2) the highlands [sierra] made up of the valleys and Western plateaus of the Andean mountains; and (3) the jungle composed of the valleys and Eastern plateaus of the Andes and the Amazon basin. The coast accounts for 28 percent (or 738,000 ha. in 1974) of Peru's arable land and all agriculture is irrigated. The most modern agriculture is found in this region. The sierra begins at an average elevation of some 4,500 feet above sea level and comprises 40 percent of the arable land (or 1,318,000 ha. in 1974). The ecology of this region is very diversified. Most of the sierra's land is pastures (around 14 million ha.) and a relatively small portion of the arable land is irrigated (27 percent). The jungle is the largest region and it has become in the last decade the second most important region for agricultural purposes. It is the region where coca has expanded.

Another classification of the country's different ecologies is by altitude [Pulgar Vidal (n.d.)]. Pulgar Vidal's regionalization of the country is very important because one can easily identify the diverse constraints imposed by ecology on the inhabitants and on the agricultural possibilities.

This alternative classification identifies eight ecological regions: one in the coast, five in the sierra (yunga, quechua, suni, puna and

---

sumed 1 tm/ha; the legal areas with coca are 17,914 Ha (1987) and there are 25,464 legal producers]. Because of the current low price of coca leaf in the black market, illegal producers have requested ENACO to purchase their crops, but ENACO can not buy leaves from producers who are not legally registered.

[6] There are other estimates quoted by the press which are of even more questionable quality and which I will not cite here.

cordillera), and two in the jungle (lower and upper jungle). A very important feature of the ecological classification is that it highlights the constraints which ecology imposes on production. Every ecology allows the growth of very specific products, and the higher the ecological level, the fewer the products which can be cultivated. For instance, in both the "suni" and "puna" ecologies between 10,500 to 12,000 feet and 12,000 to 13,000 feet, respectively, where 17 percent of the highland rural population lives, only a few products like maize, wheat, Andean crops and some fruits can be grown. Coca in Peru is produced in the upper and lower lands of the jungle.

RURAL POVERTY IN PERU

In Peru, 32 percent (1987) of the population lives in the rural areas contributing 12 percent of their GDP (Gross Domestic Product) (average 1985–87).[7] Also most of the very severe poverty is concentrated in the rural areas, and in particular in the Andean rural areas [World Bank (1988)].

Indeed, rural poverty is very extreme in the Andes of Peru and is comparable to countries of the least developed world in Africa and Asia. Caballero (1981: 208) in an extensive analysis of the Andean economy of Peru estimated that during the late 1960s and early 1970s, the income per capita in the Andes ranged between $US 30 and $US 160, and the income per capita of the Andean peasant in early 1970s was about $US 50. Although not directly comparable, Cotlear (1987:5) studied peasant families in different areas of the Peruvian Andes whose incomes in 1982–1983 ranged between $US 157 and $US 620, figures well below the average income per capita of the country in the same period [about $ US 1,100; World Bank (1985)].

Using more recent data, the World Bank's *Living Standard Measurement Study* indicates that about 31 percent of the poorest in Peru lived in the rural districts of the Andes (sierra) in 1985–86. A National Planning Institute Study on *Critical Poverty in Peru* complemented this finding indicating that most of the provinces in the *Trapecio Andino* (33 out of 42) showed the worst indicators of poverty [World Bank (1988, vol 2:51)].

PATTERNS OF FOOD CONSUMPTION AND PATTERNS OF RURAL MIGRATION

It is well known that significant changes have taken place in the patterns of food consumption in Peru. A Western-style pattern seems to predominate in the cities, based on coastal produce (e.g., rice, white potatoes) and food imports (e.g., wheat for bread and noodles, dairy products). A rural style is still noticeable in the Andes and, based on locally produced agricultural commodities. Therefore, Andean crops have gradually been replaced in the national markets by cheaper food imports, coastal and even jungle agriculture (yellow corn and rice). Andean crops have faced a declining market causing a decrease in Andean crops output. Paradoxically, the small Andean Peruvian peasants (the majority of the ag-

[7] Data are from different issues of the National Institute of Statistics (INE), *Perú: Compendio Estadistico 1985, 1986,* and *Tercer Trimestre 1987.*

ricultural producers) are not really producing the bulk of food production in the country [Caballero and Alvarez (1981), Hopkins (1981)].

Agriculture, particularly in the Third World, is still a seasonal activity and peasants have always supplemented their income working in other occupations and activities. Andean peasants used to migrate to the coast during the planting and harvesting seasons of the former large haciendas. However, the agrarian reform cooperatives (after 1969) and the existence of a pool of semi-proletarized workers near coastal enterprises stopped this migration. In the 1970s probably as a result of the declining Andean food markets and an Agrarian Reform program which by-passed Andean peasants, this migration later turned from the Andes to the jungle [Aramburú (1989), Martinez (1985), Ferrando (1985), Bedoya & Verdera (1987)].

The jungle, an area of colonization since at least the first Belaúnde Administration (1963–68), could produce some of the food items which the urban areas required (rice, yellow corn for chicken feed, palm oil for cooking oil). In the mid- and late 1970s, coca exports soared. The jungle has thus become in the 1980s the second most important agricultural region in Peru.

III. Major Reasons Explaining COCA Expansion in Peru

There are many reasons which can explain the significant coca expansion in Peru. These reasons can be divided into economic, ecological and socio-political factors.

ECONOMIC FACTORS

Coca production for export is partially a consequence of the urban nature of government policymaking towards agriculture. Agricultural policies in Peru in the last several decades were directed to supply urban areas with cheap food and have led to deteriorating terms of trade for many agricultural products in these countries [Hopkins (1981), Alvarez (1983)], and ultimately to a lower profitability of legal agriculture. In fact, the 1969 Agrarian Reform failed in Peru because, while land was redistributed in order to promote industrialization, incomes of the new agricultural reform enterprises were hindered by almost all the other measures affecting agricultural outputs. These measures lowered agricultural profitability. What land reform accomplished, however, was social peace in the countryside. But when it became obvious a decade later (about late 1970s) that land reform had by-passed the Andean peasantry once again, conditions for peasant rebellions were ripe and the "Shining Path" was born. At the same time, cocaine became fashionable in the US and other industrial nations, and Peru could produce the raw material for it, so many peasants chose this other path.

Production of coca and its illegal by-products requires fairly low investment costs to enter and continue the activity [Morales (1989)].

ECOLOGICAL FACTOR

Another major reason for the success of coca is that coca production is perfectly suited to the ecology of a large portion of the

Andean region. The opposite unfortunately is also true: Andean highland ecology is not very suitable for the production of a number of food staples now consumed in the urban areas. Highland agriculture will not succeed economically, unless urban consumption patterns are changed towards crops which can be produced competitively in the Andes or Andean production is restructured to produce commodities for which it already has comparative advantage and can therefore compete well in the international markets.[8]

SOCIO-POLITICAL FACTORS

Another reason for the expansion of a large illegal activity may be the result of weak, underdeveloped nation-state. [Cotler (1978)]. That is, the government has been, and continues to be, incapable of controlling some areas of the national territory as well as other economic sectors developing within the country at large [De Soto (1986)]. Because of this weakness, the government fails to effectively incorporate some geographical areas and thus subdue illegal activities [cf. Thoumi (1989)]. A large scale underground economy on the frontier may undermine central government's power and legitimacy in a weak nation-state, such as Peru, in five stages. First, the government's naturally weak hold on each frontier (jungle areas) creates viable conditions for the misuse of the frontier for the expansion of coca agriculture. Second, the state has so little prestige that groups involved in the production of an illicit commodity neither acknowledge the illegality of their activity nor they abide by the weak central government. Third, as political power is correlated with economic strength, groups producing a valuable commodity, however illegal, entrench and erode further the weak legal structure. Fourth, the political and legal alienation in coca producing areas enable organized cocaine networks to build the cocaine industry by exploiting and/or making alliances with the peasantry. Fifth, the peasants' economic survival is linked to their illegal activity. Consequently, aggression to the legal repressive forces is not a conscious ideological movement, but a protection of their livelihood.

IV. Possible Consequences of the COCA Underground Economy in Peru

The successful coca export is probably benefitting in the short-run an important segment of the rural (and urban) population of the country which are directly and indirectly associated with the coca activity. This successful export growth of coca, however, can ultimately create more poverty in the medium- and long-run in the agricultural sector of this country, and possibly in the country as a whole, when all the different "costs" are taken into consideration, i.e., the economic, social and ecological costs. Although there seems to be evidence of price increases of the non-tradable commodities relative to the tradable goods as a possible consequence of the large illegal inflow of foreign exchange, the social and ecological costs are probably more important in determining this negative impact.

---

[8] Such may be the case with Auchenidae wool (llamas, alpacas, vicuñas, the South American "camels") whose excellent quality is greatly appreciated in the international market.

Furthermore, this result seems to derive primarily from the illegal nature of this activity.

First, although we are still in the beginning of our research on the underground economy we can draw the following conclusion. It seems likely (given the economic growth in the coca producing areas, Morales (1989)) that the expansion of coca production and the indirect affiliated non-agricultural activity offset the decrease in agricultural activity. Therefore, in the short-run, there is a net economic gain from coca expansion.

Second, in terms of the social costs, if one were to measure the cost of growing drug addiction in the cities (basuco smoking) and the associated losses in labor productivity related to this, the violence and institutional deterioration incidental to the illegal activity in the country, and thus the increase in cost of policing this activity, the net impact on the overall economy might be negative.[9] Morever, directly and indirectly the illegal economy seems to be supporting the guerrilla activity and therefore furthering the social imbalances of the country which are seriously undermining the roots of the state in Peru.[10]

Finally, although under the current circumstances in Peru, they are not easy to assess, deforestation, erosion and pollution must be added to the costs associated with illegal coca production. That is, destruction of the agricultural frontier and unique ecosystems. Legal production can cause similar outcomes in the fragile jungle's environment, but the illegality of coca production is posing additional threats to the environment. Coca can be cultivated using well-known techniques, but the need to hide its presence causes mismanagement of the natural resources [Dourojeanni (1989), Buenaventura (1987)]. Preliminary assessments, based on aerial surveys, seem to indicate that (a) slush-and-burn clearing used for coca crops since the late 1970's may be responsible for 10 percent of this century's total deforestation in the Peruvian Amazon [Ibid]; (b) planted on steep hillsides, coca plants are stripped of leaves in harvests as many as four times a year, leaving little or no foliage to protect soil from the constant jungle rain; and (c) stretches of the Huallaga River are believed sterile because of poisoning from the toxic substances used in the production of coca paste which are dumped into waterways.

In short, the illegality of the coca expansion may make the country lose in the medium- and long-term, the short-term benefits which may be derived from the expansion of an export crop. Institutional deterioration, political chaos and destruction of natural resources seem to be the major loses.

---

[9] There are ways to measure the social costs associated with drug addiction. Measurements of this may include medical expenses for rehabilitation and productivity losses associated with drug addiction. We are in the process of doing this for Lima, Peru.

[10] It is well known that the connection between the Shining Path guerrilla movement and the drug traffic has changed. *Sendero* seems to be the protector of the peasant rights. This "protection" is 'taxed' by *Sendero* and thus the illegal coca trade finances the guerrilla activity. See The *New York Times*, July 17, 1988, A.1, A.12. See R. González, "Coca y Subversión en el Huallaga." In *QueHacer* 48, September–October 1987, pp. 58–73. Gorriti (1988).

V. Conclusions: What Must Be Done

Verdera (1989) recently proposed imposing restrictions and police enforcement for the suppliers of the chemicals used in the production of coca paste. These measures were proposed as short-term alternatives to stem the illegal coca paste production in Peru. The difficulties in policing the provision of inputs make this suggestion very difficult to implement on a day-to-day basis. There are, overall, very limited alternatives in the short-run, given the extremely difficult current economic and political problems facing Peru. The solutions require medium- and long-term development strategies.

In the outlining of the reasons and consequences of the coca illegal activity in Peru, we have pinpointed the factors which are crucial in explaining the coca expansion in Peru. Leaving aside the ecological determinants, these factors are: decline of the domestic market for Andean foodstuffs, neglect of the agricultural development in the Andes, and weak legal economy and government institutions. A common denominator for solving these problems in the long-run is, however, a thorough rethinking of the overall economic development strategy of the country in which agricultural Andean development is seriously considered. This strategy should be designed to increase agricultural producers' income.

Rural development is a crucial precondition for an overall peaceful economic development of Peru. Despite having undertaken a massive land reform program, Peru still faces a very low standard of living for the (Andean) rural population. Andean peasants' living conditions must be raised in order to stop violence and oppression of the peasantry in this area.

Several years ago, Alvarez (1983), though it was an Utopian dream, under the rules of a capitalist market economy, to consider an agricultural development strategy based on Andean agriculture and substituting food imports. That is, I did not think it was feasible to attempt "gaining" urban consumers for Andean staples. Today, recent research is more optimistic about increasing agricultural productivity of the Andean peasant economy [Cotlear (1988)] through application of selective technological packages than a decade ago [Caballero (1981)]. This may mean that some Andean products may actually compete successfully against imported foodstuffs in the domestic markets.

There are many questions that must be answered, however, before and during the process of this undertaking. What Andean crops and other products can be produced competitively? What is the necessary infrastructure required to improve Andean competitiveness? Can the profitability of the overall agricultural sector improved? Can the international community help?

One thing that should be clear, however, is that it should be a process in which the producers involved can make all the key decisions to avoid repeating the failure of the imposed 1969 Agrarian Reform Program.

Gorriti (1989) and Garcia Sayán (1989) have proposed independently the implementation of neo-Marshall reconstruction plans.[11]

---

[11] The United States transferred 17 billion dollars over a period of four years—equivalent to about 1.5 percent of U.S. GNP—to help rebuild Europe after the Second World War. (Gillis, M. et al. *Economics of Development.* 2nd ed. New York: Norton, 1987, p. 366).

Given the current Peruvian economy's extremely difficult financial situation, a modest neo-Marshall plan is in the short- and medium-run, one of the few alternatives open to Peru.[12] In actuality, the tasks required in Peru are more complicated, since the country needs *construction*, not just reconstruction. Before construction, however, an urgent need exists to have very-well designed "road maps" to lead the new developments, i.e., new research is needed. People going to the rain forests come from other areas of the countryside, and perhaps the cities. How can we improve *those* areas to discourage emigration? Does it make sense to pursue the old Belaúnde dream of colonization of the jungle (an already *de facto* situation) at the expense of the natural resources of the Amazon Basin? What type of development in the rural areas will increase effectively the standard of living of the Andean peasantry and at the same time deter the "Shining Path" expansion? Can this be accomplished without an open civil war? Can urban consumers afford this alternative?

The experience of the 1970's showed clearly that the 1969 Agrarian Reform was not designed to improve the standard of living of the poorest groups in the Peruvian (Andean) countryside. The second Belaúnde Administration thus fostered conditions to undo this reform, but it did not create feasible income-generating alternatives for the Andean peasantry. The Garcia administration tried to do something for the Andean peasantry [Figueroa and Hopkins (1987)], but it was clearly not enough. Today, this task cannot be postponed any longer. Andean rural development must be seriously considered; the survival of the country is at stake.

VI. References Cited

Alvarez, E.

1990 "The Coca Economy in Peru: A Preliminary Cost-Benefit Analysis." Report prepared for F. Ebert Foundation. SUNY-Albany, (draft).

1989 "Rural Poverty and the Illegal Expansion of Coca Production in Peru." Paper presented at the XV International Congress of the Latin American Studies Association, Miami, Florida, December 4–6.

1983 *Politica Económica y Agricultura en el Perú,* 1969–1979. Lima: IEP.

1980 *Politica Agraria y Estancamiento de la Agricultura en el Peru, 1969–1977.* Lima: IEP.

Aramburú, C.E.

1989 "La Economia Parcelaria y el Cultivo de la Coca: El Caso del Alto Huallaga." in F. León and R. Castro de la Mata (eds.) Lima: CEDRO, pp. 231–259.

[12] My own rough estimates for Peru for this neo-Marshall Plan would be about $240 million annually for about five years. This estimate is based on giving $4,000 per family to the estimated 60,000 families directed associated with the coca production for the illegal markets. Logistical questions on how exactly allocate these funds and who would administer them remain crucial issues to be solved.

Bedoya, E. and F. Verdera

1987 "Estudio sobre Mano de Obra en el Alto Huallaga." Lima: Ronco Consulting.

Buenaventura, M.

1987 "Victimas del Narcotráfico." In *Medio Ambiente* No 23, Lima.

Dourojeanni, M.

1989 "Impactos Ambientales del Cultivo de Coca y la Producción de Cocaina en la Amazonia Peruana," in León and Castro de la Mata (eds.), pp. 281–299.

Caballero, J.M.

1981 *Economia Agraria de la Sierra Peruana.* Lima: IEP.

Caballero, J.M. and E. Alvarez

1981 *Aspectos Cuantitativos de la Reforma Agraria (1969–1979).* Lima: IEP.

Cotlear, D.

1987 "La Economia Campesina en las Regiones Modernas y Tradicionales de la Sierra." Paper presented to APEA Conference. Lima, July 9–10.

Cotler, J.

1978 *Clases, Estado y Nación en el Perú.* Lima: IEP.

DESCO

1988 "Coca: La Realidad que se Ignora." In *Quehacer* 52, May–June, pp. 44–50.

De Soto, H.

1986 *El Otro Sendero.* 6th ed. Bogotá: Editorial Printer Colombiana, Ltda.

Ferrando, D.

1985 "Situación Demográfica." In *La Selva Peruana Realidad Poblacional.* Lima: AMIDEP, pp. 33–57.

Figueroa, A. and R. Hopkins

1987 "La Politica Agraria del Apra en Perspectiva," paper presented to APEA conference, La Molina, Lima, Peru.

García Sayán, D.

1989 "Narcotráfico: El Emperador está desnudo," in *Debate Agrario* 6, April–June, pp. 53–68. Lima.

Gorriti, G.

1989 "How to Fight the Drug War," in *Atlantic Monthly,* July, pp. 70–76.

1988 "Democracia, Narcotrafico y la Insurrección de Sendero Luminoso." In *Democracia, Sociedad y Gobierno en el Peru.* Ed. by L. Pasara and J. Parodi. Lima: CEDYS, pp. 193–212

Hopkins, R.

1981 *Desarrollo Desigual y Crisis en la Agricultura Peruana, 1944-1969.* Lima: IEP.

Laity, J.

1989 "The Coca Economy in the Upper Huallaga." Lima. July 13.
León, F. and R. Castro de la Mata (eds.)
1989 *Pasta Básica de Cocaina.* Lima: CEDRO

Martinez, H.

1985 "Migraciones Internas. In *La Selva: Realidad Poblacional.* Lima: AMIDEP, pp. 155–176.

Morales, E.

1989 *Cocaine: White Gold Rush in Peru.* Tucson: University of Arizona Press.

Morner, M.

1985 *The Andean Past.* New York: Columbia University Press.

Mortimer, W.G.

1901 *Peru. History of Coca.* New York: Vail.

Murra, J.

1986 "Notes on Pre-Columbian Cultivation of Coca Leaf," In *Coca and Cocaine. Effects on People and Policy in Latin America.* Boston: Cultural Survival, pp. 49–52. Peña, R.
1987 "Análisis Agroeconómico de la Producción de Coca en la Región del Alto Huallaga." Lima: Project AD/PER/86/459-PNUD, August.

Plowman, T.

1986 "Coca Chewing and Botanical Origins of Coca (Erythroxylum spp.) in South America." In Pacini & Fraquemont (eds.) pp. 5–33.
1980 "Aspectos Botánicos de la Coca." In *Cocaina 1980.* Ed. by F.R. Jeri. Lima: Pacific Press, pp. 100–117.

Fulgar Vidal, P.

n.d. *Geografia del Peru.* Lima: Minerva.

Reuter, P., G. Crawford, J. Cave

1988 *Sealing the Borders.* Santa Monica, Ca.: RAND Corporation.

Rostorowski de Diez Canseco, M.

1988 *Conflicts over Coca Fields in XVIth-Century Peru.* Ann Arbor: Memoirs of the Museum of Anthropology, University of Michigan, Number 21.

Tantahuilca, C.

1989 "La Economia Cocalera y la Violencia Social," Paper presented at SEPIA, Cusco, Peru April 27–29.

Thoumi, F.

1989 "Colombian Laws and Institutions, Money Dirtying, Money Laundering, and Narco-Businessmen's Behaviour." California State University-Chico. September (draft).

Verdera, F.

1989 "Cómo acabar con la Economia Cocalera de Exportación," in *La República* May 15. p. 19. Lima.

World Bank

1988 *Peru: Policies to Stop Hyperinflation and Initiate Economic Recovery.* Washington D.C.: Latin American and the Caribbean Regional Office.

1987 *World Bank Atlas.* Washington D.C.: IBRD.

1985 *World Bank Atlas.* Washington D.C.: IBRD.

APPENDIX IV.

THE ENVIRONMENTAL IMPACT OF COCA CULTIVATION AND COCAINE PRODUCTION IN THE PERUVIAN AMAZON BASIN

Marc J. Dourojeanni
Head Professor
National Agrarian University
Lima, Peru

1. INTRODUCTION

Despite the fact that both coca cultivation and the production of cocaine basic paste seriously and irreparably damage the ecosystem, little or nothing has been written on the effect of drug trafficking on the environment. This essay will describe the overall situation and its consequences, and recommend steps that can be taken to avoid these consequences. For this purpose we have relied on bibliographical research, as well as the author's and other professionals' knowledge of the issue.

Although there are over 250 species in the Erythroxylon genus, some 200 of which grow in the western hemisphere tropics, all cultivated coca originates from just two South American species: E. coca Lam and E. novogranatense (Morris). Each of these species has two varieties: the first, E. coca var. coca and E. coca var. ipadu; and the second, E. novogranatense var. novogranatense and E. novogranatense var. truxillense (Plowman 1984). The variety coca is cultivated in the cloud forests and montane jungles of Peru; the variety ipadu (epadu) is cultivated mainly in Brazil and to some extent in Peruvian tropical rain forests (in the department of Loreto).

In Peru's coastal region, traditionally E. novogranatense var. truxillense is grown. In 1964, there were 160 hectares of this variety still planted on the Peruvian coast and 650 hectares in

the Sierra (CONESTCAR 1965). The other variety of E. novogranatense is cultivated in Colombia. There has been some confusion over this, which was reflected in the works of Bües (1911, 1935) and others, until Plowman's clarifications (1979, 1980, 1984).

Botanical studies of the genus continued over the last two decades with the works of Machado (1970, 1972, 1974, 1974a) and Ferreyra and Tovar (1966), and the former has distinguished four varieties of E. coca. This paper will refer only to the two varieties of E. coca, and will emphasize E. coca var. coca, henceforth called simply coca.

2. CULTIVATED AREA: A GREAT MYSTERY

In order to evaluate the environmental impact of coca cultivation, it is essential to determine the extension and location of the coca plantations. Unfortunately, apart from the obvious, information is scarce and unreliable. Two points are clear: the area under cultivation is much larger than what official statistics indicate, and the plantations are now concentrated in the Departments of Huánuco and San Martín, and not in the traditional coca producing region in Cusco.

In 1964, of 16,360 hectares under cultivation, 9,230 were in the valley of La Convención, in Cusco. 4,000 hectares were planted in Huánuco, 940 in La Libertad, and 850 in Ayacucho (CONESTCAR 1965). The department of San Martín did not even figure in the statistics. In 1960, Cusco produced 59% of Peru's coca leaf (de la Guerra 1961). Bües (1911, 1935) and other authors (Paez, 1937) had described a similar situation in earlier decades. Yet even then it had been noted that Huánuco presented better conditions for coca cultivation than Cusco, producing a better quality leaf with higher alkaloid content (Vila 1935, Paez 1937).

Until the mid 1960's, official statistics and reality apparently matched. Since then, the gap between the two has steadily

grown, and has now reached almost comical proportions. Nevertheless, through 1979, even the official statistics showed Cusco's decreasing role in coca production. In that year, Cusco had only 7,877 hectares of coca, while Huánuco and San Martín already had 5,320 and 1,137 hectares respectively. In 1979 ENACO (the government-owned National Coca Company) registered only 17,916 hectares of coca in all of Peru (Horna 1980), while in 1981, based upon official information, Maletta and Makhlouf (1987) indicated the existence of 19,330 hectares.

Just how distorted this official information was became evident when other official reports (FDA/USAID 1981) pointed out the existence of 12,000 hectares of coca solely within the confines of the area covered by the Upper Huallaga Special Project. Aramburú and Bedoya (1986) referred to some 30,000 hectares of coca in that same region in the early 1980's, 2/3 of which was located in the project area. According to the FDA/USAID report, the main areas of coca cultivation are Tingo María, Uchiza and Aucayacu. Non-official information from U.S. sources suggests 150,000 hectares nationwide, of which some 70,000 hectares are located in the Departments of Huánuco and San Martín. Pumrill (1986) refers to a 1980 Peruvian Senate Report which stated that illegal coca cultivation in Perú amounted to 50,000 hectares Cortázar (1986) declares that there are over 100,000 hectares planted with coca in San Martín (in the Tocache and Uchiza zone). But the leaders of the FEDIP (the Front to Defend the Interests of the People of Tocache) charged in 1986 that there were some 195,000 hectares of coca in the Upper Huallaga alone (Pumrill 1986). Marcelo (1987) estimated (based on unrevealed sources) that the coca plantations in the province of Leoncio Prado (Monzón, Tingo María, Aucayacu, La Morada) could cover as much as 40,500 hectares, with another 33,000 hectares in the provinces of Tocache and Mariscal Cáceres. But the same author claims that even those estimates are probably too low, suggesting that coca cultivation in the three provinces

mentioned may reach 160,000 hectares. To further confuse the issue, the Minister of Interior himself stated in 1987 that over 380,000 hectares were planted in coca (Actualidad Económica, 1987), although he later corrected this information.

* TRANSLATOR'S NOTE: The Peruvian government permits the cultivation of coca for traditional purposes, mainly for pharmaceutical products, for chewing and for coca tea. All licit production of coca must be registered with, and sold to, the government-owned coca company, ENACO.

From the aforementioned reports, which are not the only ones available, one can deduce that the total area planted in coca is somewhere between 150,000 and 380,000 hectares. The most likely total seems to be a little over 200,000 hectares, which would coincide with the minimum figure derived from calculating the area cultivated based on statistics of legal and illegal coca, base, and cocaine sales. The lack of precise information on such an important issue is astounding, especially considering how technically simple it would be to obtain data with sophisticated remote sensoring equipment.

If the figure of 200,000 hectares is realistic, illegal coca cultivation is ten times as great as legal cultivation and coca takes up by far the largest cultivated area in the Peruvian Amazon. According to official statistics collected by Maletta and Makhlouf (1987), at the beginning of this decade coffee was planted on 160,000 hectares, corn on 85,700 hectares, bananas on 62,700 hectares and rice on 44,500 hectares in the Amazon region. Although this author considers these figures dramatically underestimated (Dourojeanni 1986), the pre-eminence of coca is obvious. Maletta et al (1984) pointed out that of 666,668 hectares under cultivation in the jungle region, 223,976 hectares were dedicated to permanent crops; 270,219 to seasonal

or temporary crops; 172,243 hectares to pasture; and 230 hectares to reforestation. Illegal coca represents almost 30% of that total and is equivalent to 80% of the permanent legal crops.

3. COCA AND DEFORESTATION

The first and most obvious effect of coca cultivation is the deforestation of hundreds of thousands of hectares in areas not appropriate for agriculture. The deforested areas include: (i) actual coca plantations (over 200,000 hectares); (ii) plantations of subsistence crops (manioc, banana and corn) by the coca growers; (iii) exhausted lands abandoned by the growers; (iv) areas used by peasants who have fled regions dominated by narcotics traffickers and terrorists; (v) land used by coca growers fleeing police repression; and (vi) areas deforested for landing strips (which number over a hundred), camps, and laboratories. Based on detailed reports such as Aramburú and Bedoya (1986), Aramburú (1982), and Bedoya (1982, 1986) among others, which describe land use patterns in the Upper Huallaga. One can safely deduce that since the coca boom began in the early 1970's, coca production has directly or indirectly cause the deforestation of 700,000 hectares of jungle in the Amazon region.

If that estimate is accepted, one can go on to say that coca is the direct cause of 10% of the total deforestation in the Peruvian Amazon Region this century, presently estimated at some 7 million hectares (Malleux, 1975; Dancé, 1981; Dourojeanni, 1979, 1986). But coca's role since 1970's is comparatively even greater.

Deforestation, particularly in areas which, like these, are only appropriate for forestry or for reserves, has serious effects on the environment, such as the loss of soil through sudden or

cumulative erosion; the extinction of genetic resources; the alteration of the hydrological system; flooding; the reduction of the hydroelectrical potential; increased difficulty in river navigation; the lack of wood and firewood; the lack of game animals for hunting; etc. Moreover, under these circumstances burning off the woods and ground cover produced by clearing the land is almost obligatory, bringing other consequences like air pollution, the loss of soil nutrients and damage to topsoil.

Early authors (Vila 1935, Paez 1937) who described coca agriculture noted that growers preferred recently deforested areas because of their higher natural fertility, and the absence of weeds, among other reasons.

4. COCA AND SOIL EROSION

In its first published report (Dirección de Colonización y Asuntos Orientales 1947) the Agricultural Research Station of Tingo María stated: "Although coca cultivation has disastrous effects on the soil, as well as on human beings, it is widespread because it is the most profitable permanent crop in the region." Thus the problem of coca cultivation and its impact on the soil has been under discussion for at least four decades now. Tosi (1960), Ríos (1978, 1979), Peñaherrera (1982) and Sánchez (1986) among others, have studied it more recently.

The high levels of erosion associated with coca reflect: (i) the ecological zone where it is planted; and (ii) some characteristics of its cultivation, at least the way it is generally cultivated today. Tosi (1960) describes the zones where coca cultivation occurs as "humid sub-tropical forest and very humid sub-tropical forest" located between 700 and 2,000 meters above sea level. These biological zones are known as "High Jungle", although its plantation is also common in the "Edge of Forest" regions. The optimum altitude for this crop is

probably between 1,000 and 2,000 meters above sea level, where the cocaine contents of the leaf is greater (Martin 1912) and where the rain ranges between 1,000 and 4,200mm. a year, with an average of over 2,000mm. These hilly regions, with their steep gradients, favor good drainage, and are preferred by the coca growers (Vila 1935, Martin 1952). At present, coca is even found in places like "Boquerón del Padre Abad", a sub-tropical rain forest, with an average of 6,000mm. of rain a year. Coca is grown in some of the most ecologically fragile zones of the country, many of which are inappropriate for agriculture because of their susceptibility to erosion.

As if that were not enough, the methods used to grow coca in themselves promote erosion. The preferred land is: (i) sandy-clay, with good drainage capacity; (ii) gradients above 45° to help drainage, and (iii) recently cleared and burned, that is, free of any protective vegetation (Bües 1911, 1935, Denemoustier and Jacob 1912-13, Vila 1935, Martin 1935, Pacheco 1937). Moreover, coca plots must be weeded, and the soil turned, after each harvest, no less than three, and sometimes as many as six times a year. Weeding is performed by climbing the slope, uprooting the vegetation with a shovel or a spade, and removing the weeds and part of the upturned soil (Vila 1935, Bües 1935, Paez 1937, Orihuela 1953, Daneri 1974). The soil may be overturned to a depth of 15cm. (Paez 1937). As a result, the soil in the plots is stripped of all protection from the impact of rain drops, and superficial erosion is quickly transformed into furrows and deep gullies. Although coca is cultivated in shallow depressions , the anti-erosionary effect of banking up the soil is annulled. Another cause of erosion which aggravates the effect of the aforementioned factors, is the frequency of the harvests. Constant defoliation --coca is usually harvested 4 times a year-- further exposes the soil to the impact of the raindrops or to the wind during the dry season. The number of factors which combine to make coca the region's most environmentally dangerous crop is truly frightening. Table 1 attempts to summarize these factors.

TABLE 1

SUMMARY OF THE CHARACTERISTICS OF COCA CULTIVATION WHICH CAUSE SOIL EROSION

AGENT or	CHARACTERISTICS	IMPLICATIONS
Ecosystems	Cloud Forests and Montane Forests	Ecologically the most fragile soils of the jungle
Altitude	700 - 2,000m.a.s.l.	Soils susceptible to erosion
Topography	Hilly	Soils susceptible to erosion
Precipitation	1,000-4,200mm/year (x = 2,000mm/year)	Higher rainfall increases erosion
Planting on Hillsides	45° gradients	Higher gradients, increase erosion
Preference for sandy-clay soils		More erosion in gradients than in clay soils
Recently cleared and burned plots		Burning increases erosion
Planting without terraces in shallow depressions puddles and in the same direction as the gradient		Favors erosion
Weeding and raking	4 - 6 times a year	Direct impact of rain and no obstacle for erosion
Defoliation (harvest)	4 - 6 times a year	Direct impact of rain
Simultaneous weeding and defoliation		Synergism of precedent factors
Elimination of shade trees		Direct impact of rain
Overturning top soil with hoes		Loose soil, easily eroded

Sources: as indicated in text

Coca cultivation methods have changed over the years. Many authors (Denemoustier and Jacob 1912-13, Vila 1935, Paez 1937) described a method of planting coca in trenches deep enough that the seedlings, whether sown there or transplanted, did not reach the rim of the trench. For example, in Huánuco the trenches were 25cm. wide and 30cm. long, by 80cm. deep, dug in rows following the maximum gradient line, with 60cm. between trenches and 10cm. between rows to help raking and weeding and to keep the trenches from filling during raking heavy rains (Vila 1935). Moreover, before planting the coca, another species, usually manioc, pituca, or corn, was planted to shade the coca seedlings (Bües 1935, Vila 1935, Paez 1937, Martin 1952). This practice is still used and it also helps to reduce initial erosion. But there is more. It appears that it was common to grow the coca in the shade of the black or white pacay (Inga spp), planted in staggered parallel rows (Vila 1935, Martin 1952), as was later practiced on coffee plantations.

Another important consideration is that in the past, in the valley of La Convención, on the Coast, and in some other areas, coca was often planted on level ground and was even irrigated (Bües 1935, Paez 1937). Finally, there is a great deal of evidence that in pre-hispanic times, coca was generally cultivated in well-constructed terraces with stone walls. This was a relatively common practice until the beginning of this century, as de la Guerra (1961) and Paez (1937), among others, have noted. Paez explains that they used to build "bleachers", terraces or "tacamas" 50cm. wide and 40 to 80cm. high, depending on the gradient. The same author states that this method was used in Bolivia. Recent oral and written information (Terán y Sandagorda 1980) confirms that these terraces still exist in Bolivia and in Sandia, in southern Peru, and that the oldest Monzón coca fields in Huánuco still show traces of this practice. The use of terraces, with deep trenches in them, of associated plants for the initial phase, and of shade trees,

demonstrates an awareness of the erosion caused by coca cultivation, and a willingness to take rational precaution to minimize its damage. The dangers of modern coca growing practices have won the plant the epithet "the "Atila of Tropical Agriculture" (Ríos 1979). No other crop in the world causes similar levels of erosion. In addition to the cumulative erosion coca provokes, estimated at over 300MT/hectare/year (Ríos 1978), one must consider cases of violent, catastrophic erosion. Thousands of people have already died in floods and landslides in the montane jungle region of Peru. The worst case registered thus far, which took place in the Chantayacu River valley in January 1982, caused numerous deaths and was researched by Peñaherrera the same year. These ecological disasters also destroy fertile cultivated lands and infrastructure, interrupt transit, causing the loss of perishable goods; and contaminate waterways.

5. COCA, COCAINE AND WATER POLLUTION

5.1 Contaminating effects of coca cultivation

Coca cultivation requires the use of biocides ("biocidas") to control weeds and the various plagues and diseases to which it is susceptible. Moreover, like any other crop, coca must be fertilized. All use of biocides (herbicides, pesticides or fungicides in this case) is harmful, in varying degrees, to the environment. Any use of fertilizer can also have a negative impact on the environment. But in the case of coca cultivation, because the crop is so profitable and the growers generally very ignorant, agrochemicals are applied in overdoses.

Weed control, carried out with tools in traditional cultivations, is now frequently practiced with herbicides, including those based on the clorophenoxyacetates. In certain commercial mixtures, the effects of these substances resemble those of Agent

Orange (of Vietnam fame), whose lethal effects were recently verified by the high mortality rate of fish in Brazil's Pantanal del Matto Grosso (Medina et al 1987).

Beginning with its cultivation in the nursery, where it is often assailed by mole-crickets (Gryllotalpa spp.), crickets (Gryllus spp), beetle grubs (Ancistrosoma and others), and by the Rhizoctonia Fusarium Pythiu, the coca plant suffers from various phytosanitary problems. Late in its development, it is affected by leaf-eating insects like the leaf cutter ant (Atta cephalotes, A. sexdens, Acromyrmex hispidus) and leaf worm (Pieris, Eloria noyesi, Eucleadora cocae), and by different homoptera that feed on plant sap (Aspidotus, Lecanium, Lepidosaphes, Coccus hesperidum, Pseudococcus, Saissetia coffeae, Tachardiella gemmifera), and by red spiders (Tetranychus). Cerambycid beetle grubs (Trachyderes) may also attack the trunks. These problems have been the subject of numerous references, among them Barton (1929, 1930), Bües (1935), Paez (1937), Wille (1932, 1943), Piedra (1951), de la Guerra (1961) and Alata (1973). The leaf (foliage) caterpillar plague, especially Eloria noyesi, which is very common in Huánuco, was in the past controlled with arsenic compounds ("arseniato"), which had dangerous implications for the people who chewed coca leaf in the traditional fashion. Fungous illnesses like Witches Broom, Stibella flavida, Uredo erythroxili, Hypochnus rubrocinctus (Bües 1935, Vila 1935, Cárdenas 1948, de la Guerra (1961), also affect the foliage.

As far as this author knows, most of the enormous quantity of agrotoxins and fertilizers consumed in the Upper Huallaga are used in coca plantations, usually in overdoses as great as visible phytotoxicity will permit. The agrochemicals commercially known as Tiodan, Malathion, Sevidan and Taman are the most common, but there are others as well, in addition to synthetic fertilizers for leaf or root application, which are available in the national market. All these substances reach the

soil and eventually the waterways, where they damage the hydrobiological resources to an unknown but certainly important extent. On the other hand, what chemical substances do not run off into the water supply remain on the leaf, which is used to make basic paste (and eventually, cocaine).

5.2 POLLUTION RESULTING FROM COCA BASE MANUFACTURE

Dangerous as the agrochemicals are, the environmental impact of the manufacture of coca paste is much worse. The process contaminates the air, the water, and the soil. Air pollution occurs when the coca leaf is dried in ovens fired by wood from the remaining forests. Sadly, as Ríos (1979) pointed out, the ashes are simply thrown away, while the growers go on buying fertilizers.

Soil erosion, which dumps tons of sediment into the rivers, has serious repercussions on aquatic life forms. But an even more alarming kind of pollution results from the processing of the coca leaf to extract the alkaloid for cocaine. In 1935, Vila described the following steps of the process:

(i) Maceration of the leaf in water with sulfuric acid (4 parts per 1000)
(ii) Transfer to a barrel of carbonate (20 parts per 1000) followed by chopping the leaf in small pieces
(iii) Addition of kerosene and careful beating of the mixture
(iv) Removal of kerosene
(v) Transfer to another barrel of water and sulfuric acid
(vi) Addition of more kerosene and further beating, and
(vii) Percolation of the mixture to separate cocaine alkaloid.

In 1982, Siegel described a simple process used in Colombia to extract raw cocaine. The crushed coca leaf is soaked in alcohol mixed with benzine and then shaken. After draining off the

alcohol and adding sulfuric acid, the new mixture is shaken again. When sodium carbonate is added, a precipitate of raw cocaine, called base, forms. The process currently used in the Upper Huallaga, according to Marcelo (1987), involves two main steps, which he calls maceration and washing/pressing. The maceration is done using 18 liters of kerosene, 10 liters of sulfuric acid, 5 kilos of quicklime, 1 kilo of carbide and 5 kilos of toilet paper, for each 10 "arrobas" (one arroba weighs 12 kilos) of coca leaf. For the washing/pressing, they use 1 liter of acetone and 1 liter of toluene for each kilo of basic paste obtained.

Marcelo (1987), using the information outlined above and his own estimates of coca leaf production for the manufacture of cocaine base in the Upper Huallaga, also calculated the volume of pollutants entering the waterways of the Huallaga Basin. Based on an average harvest of 2,400 kg./ha/year of dry leaf, given a total 160,000 hectares of coca in 1986, he estimated cocaine base production at some 6,400MT for the same year. This, according to his figures, means that 57 million lt. of kerosene , 32 million lt. of sulfuric acid, 16,000 MT of quicklime, 3,200MT of carbide, 16,000 MT of toilet paper, 6'400,000 lt. of acetone and a similar quantity of toluene, were dumped into the rivers in 1986. While Marcelo's precise figures (1987) might be debatable, the overall picture is too overwhelming to ignore. To make matters worse, the maceration is done in pits installed in springs. The newspaper "El Comercio", on July 25, 1987 published on its front page an accusation by the Mayor of Juanjui of pollution in the Huallaga River resulting from the production of cocaine base. In operations against narcotraffickers, the police had confiscated, along with the paste, toxic substances like sulfuric acid, acetic acid and ammonia, which were later, unbelievable though it may seem, dumped into the river by order of a judge. The episode shows the depth of public ignorance about pollution.

Although only moderately toxic, kerosene, has severe consequences for local flora and fauna, especially plankton, and affects the oxygen supply. Sulfuric acid is extremely dangerous and so are carbide, calcium carbonate, acetone and ammonia. Not even toilet paper is harmless. Once they have entered the upper reaches of the Huallaga Basin, these products travel through the waterways and the food chain, taking with them their lethal effects. Many of these substances combine again in unpredictable ways and concentrate in aquatic organisms and through them can affect human beings. The result will be fewer fish, fish which are dangerous to eat, and polluted water for irrigation and consumption. The information given above implies that the streams and waterways of the upper regions of the Basin must already be sterile. Marcelo (1987) makes note of this, pointing out that the mortality of small fish (Bryconamericus, Ancistrus Pygidium), crustaceans and even river bank plants, has reached visible levels. He also mentions the unusual proliferation of the algae "sorropa" (Cladophora) which, although a source of food for fish, in such large quantities diminishes the amount of oxygen available for other species. This is probably the result of the excessive use of fertilizers. Clearly, a detailed study on water pollution problems in the Huallaga Basin is becoming more and more urgent.

6. COCA, COCAINE AND THE PRESERVATION OF ECOSYSTEMS AND GENETIC RESOURCES

This issue was covered to some extent in the discussion of deforestation. But, at this point, it is also important to emphasize that coca is being grown in the most genetically diverse region of Peru. Thanks to its rugged topography and climatic peculiarities, the high jungle and cloud forest region which Peruvians call "ceja de selva", the "eyebrow of the jungle", is home to a large number of endemic species. Of the 7 million hectares of jungle deforested during this century in the

Peruvian Amazon, the largest area is located precisely in this region (Dourojeanni 1986). Coca cultivation has played an important role in this process of environmental deterioration and consequently in the extinction of an untold --but doubtless large-- number of species of jungle flora and fauna which were brutally deprived of the ecosystems in which they developed. In the case of aquatic flora and fauna, their ecosystems have been so altered that in many cases they can no longer support life.

But deforestation is only part of the problem. The "coca zones" are a no man's land where the rule of law has been replaced with the rule of anarchy. Logging, hunting, and fishing are completely uncontrolled. Public officials have no access to the zone. The few protected areas which have been established to preserve representative samples of the ecosystems and genetic diversity of the region cannot be developed and, worse still, are invaded by drug traffickers and coca growers. The most pathetic example, Tingo María National Park, was invaded in 1972. Dourojeanni and Tovar (1972) found that the Guacharo (Gleatornis caripensis), an endangered species, had begun eating coca fruit for lack of other food. In a similar case, "El Comercio", on August 30, 1985, denounced the production of "cocaine honey" because the bees of the Upper Chicama River had begun to feed on coca flowers. The same problems are found in the lower reaches of the newly-created Abiseo National Park, in San Martín, and may be occurring in other conservation units as well, although no accounts have been published yet. Manu National Park (in Madre de Dios and Cusco) and Yanachaga-Chemellén National Park (in Pasco) appear to be particularly vulnerable. Table 2 shows conservation units, which have been or may be affected by coca cultivation.

As far as we know, two national forests (the Alexander Von Humboldt of Ucayali/Huánuco and the Apurímac of Junín/Cusco) have been partly invaded by coca growers. The first was invaded after

the construction of the Von Humboldt-Constitucion segment of the Marginal Highway. Others, like the Biabo-Cordillera Azul (San Martín and Loreto), will doubtless follow. Police operations and the new logging and government roads have spread coca growers through the entire Amazon. Their presence along the new stretches of the Marginal Highway, built during President Belaunde's administration, is massive and demonstrates the need for greater prudence in planning these road projects. Coca is adapting to lower altitudes, and because its alkaloid content is less in the lower regions, its cultivation in the Amazon basin itself will provoke even more massive deforestation. In addition, it seems clear that the cultivators are beginning to plant coca in partially cleared areas, to avoid aerial detection.

7. BY WAY OF AN EPILOGUE

This work has tried to demonstrate that coca cultivation and cocaine production have many other consequences, in addition to those which we all know, or think we know. In fact, the industry's environmental impact is very serious: so serious that the problem deserves priority treatment so that action can be taken immediately to mitigate some of its consequences. Some possible steps follow:

(i) limit the sale and transportation of sulfuric acid and other chemical products used in the production of basic paste

(ii) plan police operations in order to avoid forcibly dispersing the drug traffickers and growers through the entire Amazon

(iii) set a moratorium on the construction of new roads --which are used primarily by the traffickers-- so that the State ceases to finance the infrastructure of the illegal coca boom

(iv) increase the almost nonexistent budget for National Parks, National Forests, and other protected areas, so that their development can become part of the defense against invading coca growers

(v) better plan lumbering operations so that logging roads do not promote the expansion of coca cultivation

Crop substitution will not be discussed at length in this document. From an environmental point of view, substitution is highly desirable and some concrete technical proposals have already been put forth (Burgos 1967, Ríos 1979, Chávez 1979, Páucar, 1983). The subject is also under discussion in Bolivia (Rodríguez 1965). Nevertheless, these authors' proposals, as well as in those proposals with a greater emphasis on economic development (Hurtado, 1986) fail to note the forestry, genetic, and touristic potential of the affected regions. In spite of its technical and economic viability, crop substitution is probably almost impossible in the absence of a strong and efficient central government. The same is true for eradication, which in merely technical terms is relatively easy.

Perhaps the greatest absurdity of all lies in the fact that coca can be cultivated, and decent levels of production maintained, without causing natural disasters. The technology exists and has been practiced for centuries, if not longer. Sadly, under current circumstances, the mythical coca plant has today become a symbol of death and destruction.

TABLE 2

CONSERVATION UNITS AND PROTECTED AREAS DECLARED UNDER PRESSURE OR POTENTIAL PRESSURE FROM COCA GROWERS AND DRUG TRAFFICKERS

UNITS/AREAS	EXTENTION(HA)	LOCATION	SITUATION
National Parks			
Tingo María	18,000	Leoncio Prado (Huánuco)	Totally invaded
Abiseo	274,520	Mariscal Cáceres (San Martín)	Eastern zone invaded
Cutervo	2,500	Cutervo (Cajamarca)	Probably invaded
Yanachaga-Chemillén	122,000	Oxapampa (Pasco)	Possible invasion
Manu	1'532,806	Manu (Madre de Dios) Paucartambo (Cusco)	Possible invasion
Conservation Units Under Development			
Cutibireni	300,000	Junín and Cusco	Partially invaded
Sira-San Carlos	1'000,000	Ucayali and Junín	Possible invasion
National Forests			
Von Humboldt	645,000	Coronel Portillo Ucayali) and Pachitea (Huánuco)3	Initial invasion
Biabo-Cordillera Azul	2'084,500	Mariscal Cáceres (San Martín) and Coronel Portillo (Ucayali)	Possible invasion
Apurímac	2'071,700	Satipo (Junín) and La Convención (Cusco)	Initial invasion

Sources: Eyewitness testimony and the observations of the author

AIO:2424P:6/9/88

APPENDIX V.

(Reprinted with permission from ''Lands at Risk in the Third World'' (Peter Little and Michael Horowitz, eds.) Westview Press, Boulder, CO. 1987)

14

Intensification and Degradation in the Agricultural Systems of the Peruvian Upper Jungle: The Upper Huallaga Case[1]

Eduardo Bedoya Garland

Introduction

The ecological and productivity crisis in the agricultural areas of the Peruvian upper jungle[2] has been viewed, with few exceptions (cf. Recharte 1982), to be a result of the deforestation brought about by highland settlers (Martinez 1977). Settlers are not, of course, the only agents responsible for massive deforestation and its consequent ecological disruptions. Other factors in the relationship between immigration and environmental destruction are a state that views colonization as necessary for economic development and national security, the opening of penetration roads, and the legal land tenure system. Nevertheless, the subsistence strategies of settlers from Peru's highland areas are essential elements in the situation. As one attempts to understand why settlers frequently engage in destructive production practices, a number of issues emerge that concern resource constraints imposed by the larger socioeconomic context. These include the composition of the household production unit over time, the decisions that households make regarding the hiring of wage labor, and the relationship between current agricultural prices and household production costs.

General models of soil degradation have focused attention almost exclusively on population (Boserup 1965), technological inadequacy (Sanchez and Buol 1975), or the nature of agricultural policies (Hecht 1984). While the latter perspective offers methodological advantages over the other two, studies of subsistence strategies conducted by Peruvian researchers continue to treat environmental destruction as resulting solely from the automatic response of a group of settlers to market conditions and soil quality. In this chapter, I examine the various elements that lead to environmental disturbances and show that endogenous factors, such as farmer income-earning strategies and the size of the colonist family, are especially significant.

The approach discriminates intensive and extensive systems through an index of soil use intensity. As will be discussed in more detail below, the greater the intensity of soil use, the greater the environmental degradation.

The chapter is divided into three parts: a description of the deforestation problem; a case study of the upper Huallaga valley based on results of a survey administered in 1981 by Carlos Aramburú (1982); and a synthesis and discussion of ecological degradation, including policy recommendations.

The Deforestation Problem

Several ecologists and agricultural experts have, from different viewpoints, indicated the negative effects of agricultural practices employed by immigrants in the Peruvian Amazon, especially in the upper jungle. Malleux (1975) and Martinez (1977), for example, discuss the huge area that has been deforested. In the course of the last 50 years, approximately 5,122,000 ha have been cleared. Even more serious, however, is the fact that the rate of deforestation is increasing exponentially, such that every year the area of land deforested is about 12 percent greater than the area deforested the previous year. At this rate, we can expect an additional 20 million ha of land in the Peruvian Amazon to be ruined during the period 1985–1999. In the year 2000 alone, less than 15 years from now, more than 2.5 million ha will be cleared if present trends continue unabated. José Dance (1979), more optimistic but also critical, calculates the current annual deforestation rate at 254,000 ha annually per year and projects that it will reach 339,000 ha annually by 2000. Dourojeanni (1984) predicts that over 11,000,000 ha will have been deforested by 2000.

The estimates specifically for the upper jungle are also discouraging. Approximately 3,389,000 ha have been destroyed in 50 years. In both the lower Amazon basin and the upper jungle, productive use of the cleared land is minimal: only one in every four deforested hectares currently has an agricultural use. Thus, in spite of massive deforestation, only 1,280,000 ha in all of the Peruvian Amazon are being used for agriculture, of which 850,000 ha are located in the upper jungle (Dourojeanni 1981). Despite such unproductive use of land resources, some advocates of settlement have argued that there still remain 63,588,000 forested hectares, and continue to view settlement as a way of addressing land distribution problems. This view lacks scientific justification. In the land now in fallow, huge areas are so badly degraded that they have been lost from all productive use (Agreda 1984). Of the 3,389,000 deforested hectares in the upper jungle, around 2,610,000 ha constitute an area at fallow, but not all of this area is potentially arable. The fact is that two of every five deforested hectares are not suitable even for reforestation. These were cover forests, situated on steep slopes of more than 40 degrees, which were useful as natural protection against erosion, as habitat for animals and plants, and as a defense of the Amazon's downstream hydro-energy resources (Goodland 1980).

Víctor Agreda (1984), in his recent research on the expansion of the agricultural frontiers of Peru, classifies degrees of susceptibility to soil erosion

in the upper jungle. In that region, the soil not only is low in fertility due to scarce organic content (Meggers 1971) but most is also located on highly erodible slopes. According to Agreda, 47.3 percent of these lands has a high degree of susceptibility to erosion, 38.4 percent an intermediate level of susceptibility, 8.2 percent a low level, and only 6.1 percent is not susceptible to erosion. We must conclude from Agreda's classification that the upper jungle of the Amazon basin is a region at high risk. This conclusion is reinforced by the land-use classification of ONERN (Oficina Nacional de Evaluación de Recursas Naturales, the National Office of Natural Resource Evaluation), which holds that 29 percent of the soils of this region is suitable only for cover or natural protection and 40.5 percent for use in forestry. Of the 13.8 percent of the land area classified as appropriate for permanent crops, a significant sector will support only moderately light use. While 30.5 percent of the land area in the upper jungle is suitable for some form of agricultural or pastoral exploitation, as compared to only 13.7 percent in the lower basin, nearly a third of the land of the upper jungle is unsuitable for any form of exploitation (Agreda 1984:18–19).

In the interior of the upper jungle, certain basins have been affected more than others. In the Department of San Martín, 42 percent of deforested hectares is concentrated in areas classified as forest without agricultural potential, while in Amazonas it is 65 percent, in Huánuco 61 percent, in Junín 58 percent, and in Cuzco 77 percent (Dance 1979). Generally speaking, the upper jungle regions, which contain 52 percent of the Amazonian population (Lesevic 1984), suffer the most negative effects of deforestation. Moreover, in certain basins, such as Satipo, upper Urubamba, and Oxapampa, that are classified as alluvial forests with high natural suitability for farming, practically no agriculture has been developed. Instead, the bulk of agriculture is concentrated in lands of little or no agricultural potential. The consequences are evident: loss of hydroenergy potential of the upper jungle; reduction of riverine navigation; repeated destruction of roads, communication facilities, and villages by landslides; and irreparable damage to the weak balance of the tropical humid forest (Dourojeanni 1984; Agreda 1984).

Various officials of former president Fernando Belaunde's regime consider the upper Mayo region in the northern part of Peru's upper jungle, where irrigated rice cultivation has been developed during the last eight years, to be an example of effective spontaneous settlement.[3] In this basin ecological deterioration is not as great as in other areas, but problems of soil mismanagement nevertheless arise. In the upper parts of the Yuracyacu River, a tributary of the Mayo River, cover forests, or areas recommended for strict forestry use, have been cleared for annual crops. A major negative effect of this has been water filtration or evaporation at the source of the river, which has severely endangered plans for the future expansion of irrigated agriculture in the area (Bedoya 1985). The case of the Marañon basin, in the northern high jungle on the Ecuadorian border, is probably the most significant example of the use of soil unsuitable for permanent crops due to its steep slopes. Only about 37,000 ha in the basin are suitable for

permanent crops, but 47,404 ha were planted in coffee in 1980. Approximately 14,704 ha of the coffee were sown in cover forests or in soil recommended exclusively for forestry activities. Some have gone so far as to blame this indiscriminate deforestation for the sharp decline in local rainfall in 1982, when there were 700 mm of rain as opposed to the average 1,500 mm (Peñaherrera 1984; Paredes 1983a, 1983b).

Settlers of the upper jungle have traditionally been stereotyped as practitioners of shifting agriculture. According to a survey by M. Dourojeanni (1981) on the lower Mayo-central Huallaga basin, 9 percent of the total hectares cleared in 1980 was in effective agricultural use, 14 percent was made up of pastures, and the remaining 77 percent was in fallow. At that time, only 50 percent of the land classified as in agricultural use was being worked under shifting cultivation, while 40 percent was under permanent agricultural production with a fallow period and 10 percent of the land was under permanent cultivation with no fallow, growing crops that require intensive use of the soil—either annual crops such as irrigated rice, or permanent plantation crops such as coffee, cacao, coca, or tea.

With regard to shifting agriculture, not much research has been carried out and little is known. Watters' (1971) enquiries during research on peasant technology in the upper Huallaga in the 1960s include some useful indirect references to shifting agriculture, but they lack specific data (see Aramburú 1980). On the other hand, some authors have projected the figures calculated by Dourojeanni in the central Huallaga to make inferences about agricultural patterns throughout the upper jungle basins (Agreda 1984). In view of the existence of several levels of intensity of soil use throughout this region, however, these projections are not likely to be accurate. In some areas where permanent crops now dominate, shifting agriculture has been significantly reduced, especially as agricultural settlement areas begin to experience economic consolidation. For instance, a recent inquiry in the upper Huallaga indicates that only 40 percent of the settlers have cultivated one or more plots in addition to the one they are presently working (Aramburú et al. 1985).

It is, in any event, not fair to blame only those settlers who practice shifting cultivation for the deforestation of 39 percent of the jungle. Permanent as well as shifting agriculture has been carried out in areas recommended exclusively for forestry use or protection. In the Tingo María area, for example, the former large tea and coffee plantations now reorganized as production cooperatives, such as CAP (Cooperativa Agraria de Producción/ Agrarian Production Cooperative) Jardines de Té El Porvenir, and CAP Té-Café, also have occupied areas that were recommended solely for forestry use. In previous studies (Bedoya 1981; CENCIRA 1973) I have pointed out the economic unsuitability of mechanical clearing in this region. A further problem, the inappropriate locating of plantations on steep slopes, led to the destruction of tea and coffee fields in 1982, when a minor earthquake caused a landslide in the area.

From a number of sources, then, the Peruvian upper jungle has been subject to resource abuse and degradation. In what follows, I turn to an

analysis of the case of upper Huallaga valley, located in the department of Huánuco, which, as has already been indicated, is one of the most deforested regions of Peru's upper jungle.

Agricultural Systems in Upper Huallaga

The upper Huallaga basin (Figure 14.1), located in the central upper jungle, contains 10.2 percent of the total population of the upper jungle—1,221,351 inhabitants (Lesevic 1984)—and comprises 3,373,600 ha of the zone's 27,355,300 ha (Peñaherrera 1984). It represents a classic pattern of population settlement, though more recent than settlement in the basins of Chanchamayo, Jaén-San Ignacio, and central Huallaga.

Research on the upper Huallaga basin shows that there are two main agricultural systems. One is dominated by the permanent plantations of coca, tea, coffee, and cacao, which, in 1980, accounted for 61 percent of the agricultural area. The other consists of annual food crops, such as manioc, yellow corn, starchy corn,[4] and dryland rice. Annual crops accounted for 12 percent of the agricultural land under production in 1980. In 1972, eight years earlier, annual crops had accounted for 60 percent of the hectares in agricultural production. Of the remaining area (40 percent), 30 percent was covered with permanent crops (coca, coffee, tea), and 10 percent with semipermanent (banana) (CENCIRA 1973). The studies also show that each settler manages a small family garden of crops either for household consumption or for experimenting with possible cash crops.

The dramatic increase in coca (*Erythroxylon coca*) production, from about 2,228 ha in 1973 to at least 30,000 ha in 1980, explains the predominance of permanent crops that characterizes the latter year. It has been, of course, the growth of the drug trade that has stimulated these drastic changes in land use. The production of coca allows settlers to extend cultivation into more marginal areas, for it offers the possibility of exceptional profits. One hectare of coca, transformed into cocaine paste,[5] represents an income of US $30,000 per year. This return is ten times higher than the next most profitable crops, cacao or irrigated rice.

The expansion of coca production in upper Huallaga is the result of a long process of change. Since the opening of the road to Huánuco, Tingo María, and Pucallpa in the 1940s, the area has received a massive number of settlers migrating from the highlands. Large commercial estates also were established at that time, including Jardines de Té, Pra Alto, and Santa Elena (Bedoya 1982a; 1982b). Initially, the coffee and tea plantations were located in the best alluvial lands and flat gradient hills of Tingo María, while smallholder settlers from the Andean highlands were located on the most marginal areas, classified for forestry use or protection forest. Subsequently, construction in the mid-1950s of the central Huallaga road from Tingo María to Aucayacu resulted in increased colonization in this area by both Andean settlers and former Amazon riverside inhabitants who were hired to build the road. In the 1960s, the government-sponsored Tingo María-

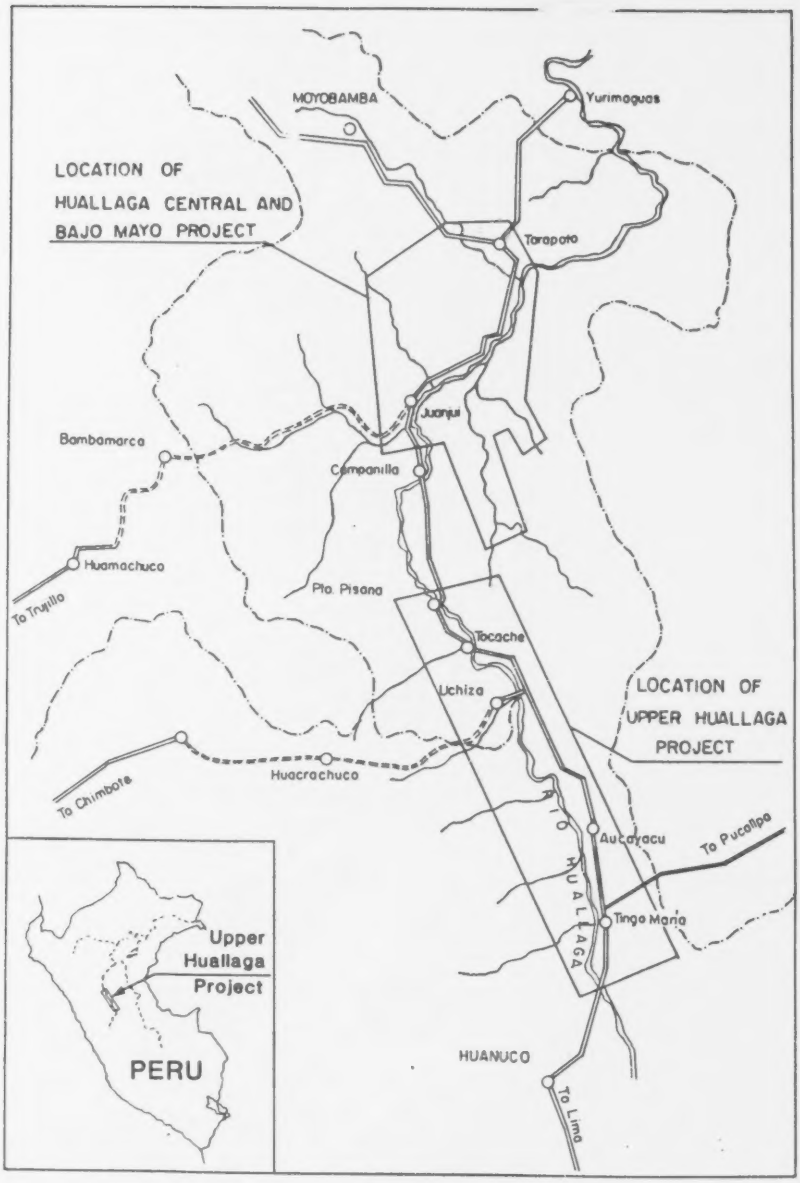

Fig. 14.1 Map of Huallaga Valley.

Tocache and Campanilla settlement program was initiated. The purpose of the effort was to locate or relocate 4,680 families, most of them spontaneous settlers, and to make use of 130,000 ha for such commercial crops as oil palm, rubber, and citrus fruits (Bedoya 1981). More recently, between the late 1960s and the early 1970s, Tocache and Uchiza zones became the regions of demographic and agricultural expansion (Aramburú 1980). As in the Aucayacu region, settlers in these two zones did not experience problems resulting from the occupation of the best soils by big plantations, as had settlers in the Tingo María region.

In summary, we can identify three settlement frontiers: the oldest one in Tingo María, where massive migratory settlements occurred in the 1940s and 1950s; a second frontier in Aucayacu during the 1960s; and a third frontier in Tocache and Uchiza in the 1970s (Aramburú et al. 1985).[6] Although large holdings were developed, particularly in Tingo María, the three regions underwent spontaneous settlement by populations from the highlands. In all three, limitations on the availability of land suitable for cultivation reproduced a peasant economy similar in many respects to what settlers had left behind in the highlands, even as the new physical environment stimulated innovations in household subsistence strategies.

During the 1960s and 1970s, however, large properties in Tingo María entered into an economic and institutional crisis. Under the provisions of agrarian reform instituted under the government of General Juan Velasco Alvarado, private estates, such as Jardines de Té, were converted into state cooperatives. Beginning in the 1960s with private firms—Saipai, for example—and continuing into the present with the state production cooperatives, commercial enterprises have experienced financial problems and economic failure. The principal cause of these difficulties has been the inability of commercial plantations and cooperatives to retain their labor supply. Throughout the upper Huallaga region, the availability of land facilitated the transformation of indebted plantation labor forces into independent smallholders managing plots outside of the plantation lands. The resulting labor scarcity impacted adversely on the production plans of commercial enterprises. Since 1978 coca production has been more profitable than tea or coffee production for cooperative members and potential hired laborers at CAP Jardines de Té. For cooperative members, the possibility of large and immediate earnings through cultivating coca was more attractive than any long-term benefits they saw accruing from participation in the cooperative. For wage laborers, wages paid by coca farmers were almost twice those paid by the tea cooperative. While CAP Jardines de Té had many financial and administrative problems, competition generated especially by coca activity led to a chronic labor deficit between 1978 and 1982. Thus, during this period, the number of workers at CAP Jardines de Té decreased from 375 to 202. This created intolerable financial pressure in the upper jungle, where large properties, under a wide range of economic conditions, have historically suffered a chronic labor shortage due to the competition generated by the economic expansion of the peasantry (Bedoya 1983). Taken

together, these conditions led upper Huallaga plantations, although changed into cooperatives, almost to disappear from the region as significant agricultural systems. In the 1970s, management of the agricultural cooperatives was the responsibility of the settlers with farms of 20 to 30 ha. Except for CAP Jardines de Té, the cooperatives went out of business. In CAP Té-Café, members even substituted coca plants for coffee. With the disintegration of cooperatives, many settlers who were former members began to occupy alluvial lands or lands of better quality than those occupied by older peasants in the Tingo María region.

On the other hand, the production of crops (such as rice and yellow corn) for direct urban consumption was not promoted as strongly in the upper Huallaga region as it had been in such other areas of Peru's upper jungle, as the central Huallaga River basin and the upper and lower Mayo River basins, in spite of pricing policies implemented by the Velasco military government (1968–1975) to encourage this activity. In the first place, a large number of the settlers who moved into the central Huallaga and Mayo basins came from Bagua, in Amazonas department, and were familiar with the technology and cultural practices associated with irrigated rice production (Gonzalez 1983). Settlers arriving in the upper Huallaga area came, by contrast, from highland areas of Huánuco department. They had experience with irrigated agriculture, but with a totally different technology, based on temporary structures to manage water from rainfall (Caballero 1981).

Second, settlers in the central Huallaga and Mayo River areas benefited from higher quality soils than did their counterparts in the upper Huallaga. For example, the upper Mayo River basin has four times the amount of arable land as the lower Mayo and Huallaga basins, and fifteen times the amount of arable land as the upper Huallaga (Gonzalez 1983).[7] Such differences led to more intensive land use and more productive agriculture in the Mayo and central Huallaga basins than in the upper Huallaga. So, in 1981, the average yield of unirrigated rice in upper Mayo was 2,200 kilograms per hectare, while in upper Huallaga the overall average yield was about 1,800 kilograms per hectare, with rice yields in some areas approximating the 1,389 kilograms per hectare recorded in Tingó María. Similar differences in yields characterize the production of other important crops such as corn, manioc, and beans (Gonzalez 1983; Aramburú et al. 1985). These differences in productivity placed upper Huallaga farmers at a disadvantage in relation to farmers in other Huallaga and Mayo River areas.

A third factor responsible for the low productivity of the region was the minimal use of inputs. To a certain extent, this resulted from the differences in productivity discussed above. If yields are low, in relative terms, input costs become too expensive. Since 1976, however, the economic stabilization rules imposed by the International Monetary Fund, which removed subsidies and let the market reflect the real scarcities, have reduced effective urban demand for foodstuffs and agricultural products. Moreover, the terms of trade between agricultural prices and input costs have shown an increasingly

unfavorable trend for the producer since 1973. The modern capitalist farmers were badly hurt by this, but for traditional farmers like those of upper Huallaga, the rise in relative prices of inputs was less important, since their use was already low (Alvarez 1983). In the economic crisis of 1981 to 1983, the terms of trade deteriorated even further. Overall production costs increased 2.7 times more than prices did, rising 1.6 times faster than the price of corn, 4.1 times faster than the price of manioc, and 8.1 times faster than the price of bananas (Aramburú et al. 1985).

In this context of unfavorable prices and low productivity for other crops, coca production burgeoned, but the expansion of coca has created ecological problems throughout the upper Huallaga.[8] First, as a result of its high price, coca is cultivated in large areas as a monoculture, with an almost complete lack of protection and without proper spacing or density. Second, as in other upper jungle zones, coca—like cacao, tea, and coffee—is grown on land suitable for agriculture or for forestry, removing it from other types of production. Even more ecologically damaging, due to the illegal nature of this crop settlers try to cultivate it in locations remote from roads. The hillsides are the safest alternative, but though it is a permanent crop, coca has the harmful effects of an annual crop when it is cultivated on deforested steep slopes. This is particularly true because it is typically cultivated in vertical furrows rather than in terraces that soften the damaging effects of rain.

If the current rate of increase in the area dedicated to coca production continues, the environmental destruction will be exacerbated. There are 193,600 ha suitable for annual crops in upper Huallaga, and 58,600 ha recommended for permanent and semi-permanent crops. But, as in other regions, the dynamics of development have caused land use patterns to be the reverse of those that are technically most advisable. Permanent crops like coca, coffee, and tea are the most widely cultivated, and these are encroaching upon lands best suited for annual crops.

Intensification of Soil Use and the Process of Degradation

The production of coca and annual crops has led to ecological degradation in the upper Huallaga basin. The degree of degradation can be measured as a function of the intensification of soil use, which is reflected in the shortening of fallow periods or a decrease in fallow area. The process of intensification is measured by the formula: (permanent crops + annual crops) divided by (permanent crops + annual crops + fallow grass). For instance, for plots that have an intensity of 0.1, 6.24 hectares at fallow correspond to each cropped hectare; for farms with an intensity of 0.9, only 0.11 hectares at fallow correspond to each cropped hectare. In other words, the lowest indexes correspond to the most extensive systems, the highest indexes to the most intensive systems.

As may be seen in Figure 14.2, shorter fallow periods are not accompanied by increases in modern inputs. Official figures indicate that about 7 percent

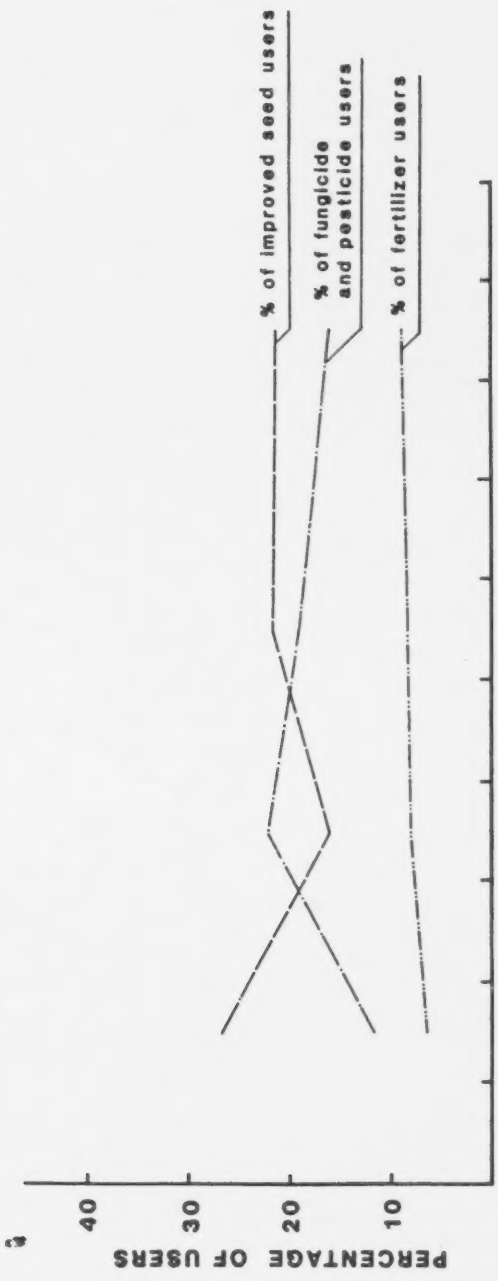

Fig.14.2 Percentage of Modern Input Users and Intensity of Soil Use.

of settlers use fertilizers, about 16 percent use insecticides and fungicides, and 21 percent use improved seeds. The inputs are not applied as part of an overall package, however, but individually, according to what can be purchased at a particular time at a particular price. Most households in the upper Huallaga vary their economic strategies according to prevailing market conditions for agricultural products, the availability of unpaid family labor, and their need and capacity to hire wage labor. The purchase and use of capital inputs becomes part of this process only after labor requirements have been met. A household with sufficient members between the ages of 10 and 24 to carry out the bulk of its productive activities is relatively likely to use modern inputs, because it does not have to spend scarce funds on securing labor (Figure 14.3).

While abundance of household labor is accompanied by relatively high use of modern inputs, abundance of land seems to diminish their use. Thus, in regions such as Tocache and Uchiza where land is relatively plentiful, the use of modern inputs is remarkably less than in Tingo María, an area with higher population. In the former zones, two-thirds of the settlers do not use any kind of inputs, while in Tingo María exactly the opposite situation prevails. Tingo María has a population density of 52.30 inhabitants per km^2—a medium-high density according to Boserup (1984)—and an average farm size of 19.50 ha (Table 14.1). Tocache and Uchiza have a medium-low density of 24.65 inhabitants per km^2, an average farm size of 30.07 ha. Obviously the greater availability of land is leading toward more extensive use of soil. As in the upper Huallaga, farmers who utilize modern inputs do so selectively, in a piecemeal fashion, rather than as part of a single technological package. As a result, in 1981, 68 percent of the settlers in Tingo María could not cultivate the total area of their plots due to soil exhaustion, in spite of the fact that they are relatively heavy users of modern inputs.

Several factors are related to the intensity of soil use. First, greater soil use intensity is inversely related to plot size. Figure 14.4 illustrates this relationship: while the smaller plots are concentrated on the higher indexes—0.7 to 1.0—the larger farms are on the lower indexes—0.1 and 0.2. However, the relationship between plot size and soil-use intensity is the strongest in the older settlement areas of Tingo María, and relatively less important in the Aucayacu and Tocache-Uchiza regions. This is because the pressures to utilize the soil more intensively increase as plot size decreases, and the relationship becomes progressively stronger as the person-to-land ratio increases.

In Tingo María the smaller size of plots is a result of a dynamic land market. Although there is no information for the 1970 to 1980 period, available data show that the number of farms in the area has increased approximately 800 percent during the 1980s alone (Bedoya 1986). The rise in land value is obviously a consequence of coca's profitability. However, such an increase in the number of farms not only reduces their average size but makes the already scarce "free" land less plentiful. Intensification

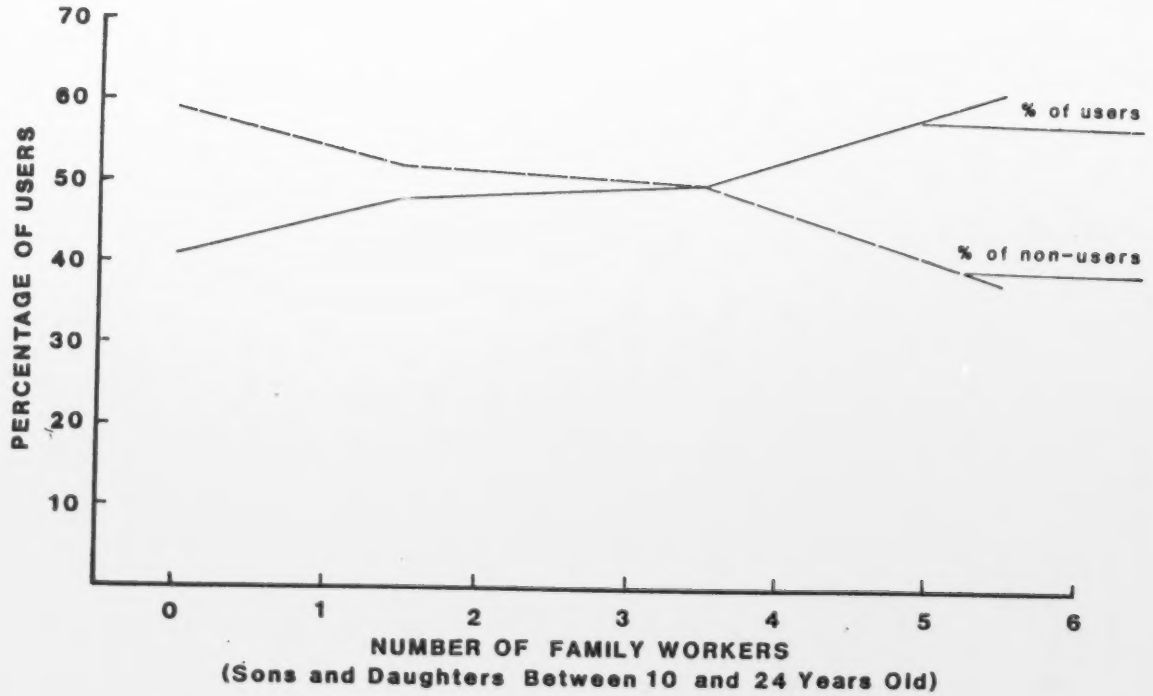

Fig. 14.3 Number of Family Workers and Use of Modern Agricultural Inputs.

Table 14.1 Population Density and Soil Use in Upper Huallaga Valley

Population Density (people per square kilometer)	Tingo María (older area)		Aucayacu (intermediate area)		Tocache and Uchiza (new areas)	
	52.30		18.38		24.65	
Average hectares per plot	19.5	% 100	26.75	% 100	30.07	% 100
Average hectares in permanent crops	4.73	24	3.38	13	2.34	8
Average hectares in annual crops	1.47	8	2.54	9	3.71	12
Average hectares in pasture	2.71	14	5.02	19	4.60	15
Total hectares in agriculture and pasture	8.91	46	10.94	41	10.65	35
Average hectares in fallow grass	5.09	26	7.96	30	9.22	31
Average hectares in forest	5.51	28	7.85	29	10.18	34
Intensity of soil use	0.55 (medium)		0.43 (low)		0.40 (low)	

Source: Bedoya 1986.

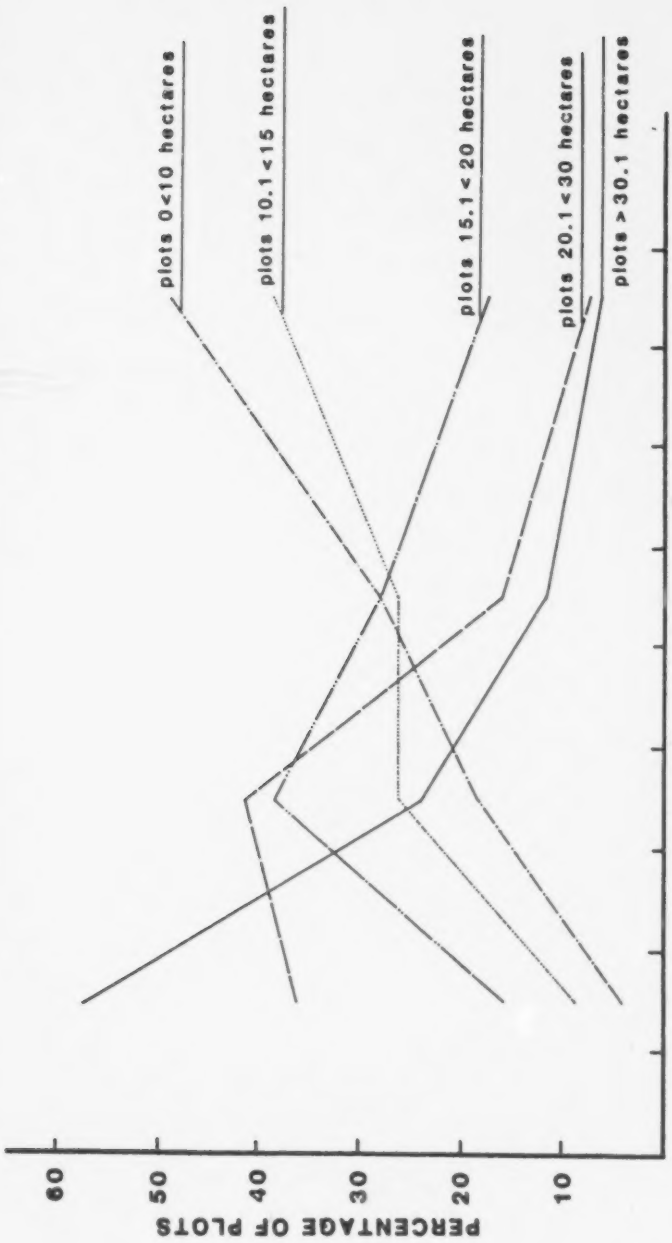

Fig. 14.4 Size of the Plots and Intensity of Soil Use.

Table 14.2 Intensity of Soil Use and Cropping and Fallow Periods (Annual Crops) in Tocache, Uchiza, and Aucayacu

Intensity of Soil Use	Number of Cropping and Fallow Years	
0.1 to 0.2 (very low)	2 cropping and 4 fallow years	3 cropping and 8 fallow years
	3 cropping and 6 fallow years	
0.3 to 0.4 (low)	2 cropping and 3 fallow years	3 cropping and 4 fallow years
	3 cropping and 5 fallow years	
0.5 to 0.6 (medium)	2 cropping and 2 fallow years	
	3 cropping and 2 fallow years	
0.7 to 0.9 (high)	2 cropping and 2 fallow years	

Source: Bedoya 1986.

is thus an immediate alternative to acquiring more land, but it results in serious degradation.

For annual crops, the relation between cultivated and fallow periods in upper Huallaga basin is an additional symptom of degradation. If land is less accessible, fallow years will be shortened and soil exhaustion will increase. As production systems have evolved on colonists' farms in Tocache and Uchiza, as well as in Aucayacu, greater intensity in soil use has accompanied a shorter fallow period (see Table 14.2). In Tingo María, however, the trend has been irregular. In the intensity indexes that run between 0.1 and 0.2 the fallow periods for annual crops are some four years longer than the cropping years. The length of fallow diminishes as the intensity index increases to 0.6, when cropped years exceed fallow. But

for indexes above 0.8, cropped years decline and years in fallow again exceed cropped years. That is to say, the agricultural history of the upper Huallaga valley has been characterized by a shift away from extensive annual systems located in areas of recent occupation, toward a reduction of fallow periods in areas occupied for intermediate periods of time. But, the system finally regresses, with the reestablishment of extensive annual systems as the effects of soil degradation are felt. This pattern is similar to the one described by Recharte (1982) for the Chanchamayo region. Furthermore, in the area of Tingo María, there is evidence of profusion of "toro urco" (*Paspalum paniculatum*), a naturally occurring variety of pasture grass that is an indicator of degradation, in a higher proportion than in Tocache and Uchiza. The small size of domestic livestock that live off this grass also indicates soil exhaustion. In such a situation, coca, due to its rapid growth (eight months between planting and first harvest) and easy cultivation even on steep slopes, is the most attractive alternative. Coca has paradoxical significance for Andean agriculture and environment: on the one hand, it is a highly erosive crop because of its sowing method; on the other, it can be produced on degraded lands.

Changes in cropping patterns seem to be a factor in soil use intensification. Farms with cropping patterns based primarily on annual crops have a lower intensity than do farms where permanent crops predominate (Figure 14.5). However, the influence of the cropping pattern is perceived only at the overall regional level. In a specific area such as Aucayacu, where a dramatic transition from annual to perennial crops took place, local factors may obscure the relationship (Table 14.1).

Variations in settlers' economic strategies are also a factor underlying soil intensification. As may be seen in Figure 14.6, an orientation more linked to a market economy is associated with a greater intensification. Changes in the intensity of soil use occur simultaneously with variations in the number of crops under cultivation and the degree to which plots are dedicated to production for market or for household consumption. According to Figure 14.6, the cultivation technique of combining one commercial crop with two or more crops for family consumption is associated with relatively low intensities of soil use. However, in the medium and high ranges of the soil intensity index, the dominant pattern is a combination of two commercial crops and one subsistence—usually annual—crop. In this last period, characteristic of Tingo María, there is specialization, with permanent crops grown almost exclusively for markets, and annual crops for family consumption. This transition from subsistence to commercial production occurs in such a way that the present system is not likely to be sustainable under humid tropical conditions. The practice of simplifying the production system to include only one or two crops, usually sown in adjacent or contiguous areas, provokes biological degradation (cf. Meggers 1971; Camino 1984).[9]

Finally, family size plays an important role in determining the intensity of soil use. In the most populated areas, like Tingo María, increasing family

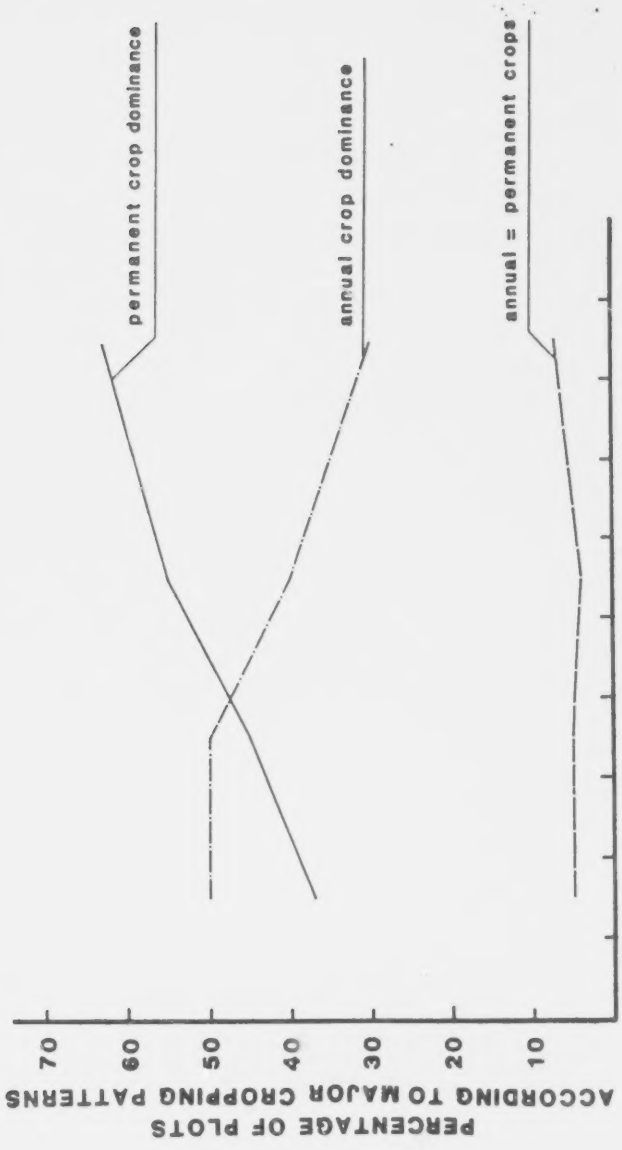

Fig. 14.5 Major Cropping Patterns and Intensity of Soil Use.

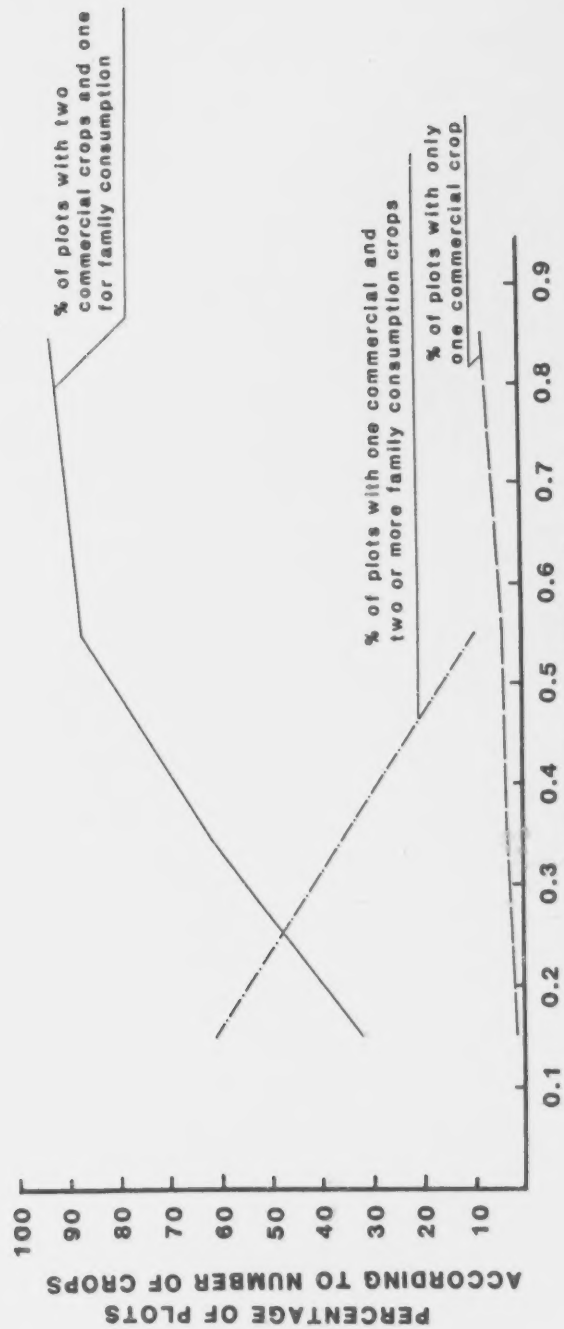

Fig. 14.6 Number of Crops and Intensity of Soil Use.

size leads toward greater intensification; while in Tocache and Uchiza, where farms are bigger and land is available, the larger families enlarge their total number of cultivated hectares. This explains the fact that in Tocache and Uchiza average farm size is higher than in Tingo María (10.65 ha and 8.91 ha, respectively). A larger number of available hectares correlates positively with a larger average farm size; while fewer available hectares corresponds with greater intensification.[10] Such a trend is similar to that noted by Chayanov (1966) in reference to domestic intensification in the case of an increase of children (Figure 14.7).

In summary, four factors influence the intensification of soil use: farm size, cropping pattern, the degree of market orientation among settlers, and family size. The relative influence of each factor depends on the age of the settlement and the density of population. In any case, the Tingo María region, with greater soil-use intensity, has the worst soil exhaustion and degradation.[11]

Institutional and Ideological Factors

In addition to the physical factors underlying soil-use intensity mentioned in the previous section, variables of an institutional nature are also dynamically involved. First, for example, squatters without legal land tenure certificates are responsible for much of the accelerating process of deforestation. Squatters deforested at a rate of 1.09 agricultural hectares per year, while legal tenants or grantees did so at a rate of 0.54 ha (Bedoya 1986). The need to obtain a legal certificate to settle permanently on a plot and acquire a credit rating forces squatters who practice shifting agriculture to clear land more rapidly than colonists who already own their farms. The certificate of possession, prior to the legal title of property, recognizes only the area under cultivation, and excludes the remaining hectares, which bear fallow grass, protection forest, and so forth. At the same time, the certificate of possession is a prerequisite for legal titling of the property in the future. If only a few working hectares are recognized in the certificate of possession, the officers in charge of land concessions will not in the future give or assign to the colonist the appropriate number of hectares. Thus, at the beginning colonists will try to work the largest possible number of hectares, but after they have devoted some years to obtaining the certificate of possession, the soils will already have been used intensively. That is why the settler with a land title averages around 0.54 (medium intensity) compared to that of precarious occupants with a certificate (0.34—low intensity). Perhaps in the past, when the abundance of land did not force colonists to have a property title, soil use was more extensive. Now, however, the reduced availability of land leads squatter colonists to intensify its use.

Second, it has been demonstrated that, given equal soil quality and equal number of years on the farm, the highland colonist utilizes significantly more intensive systems than the jungle colonist. The intensity levels in

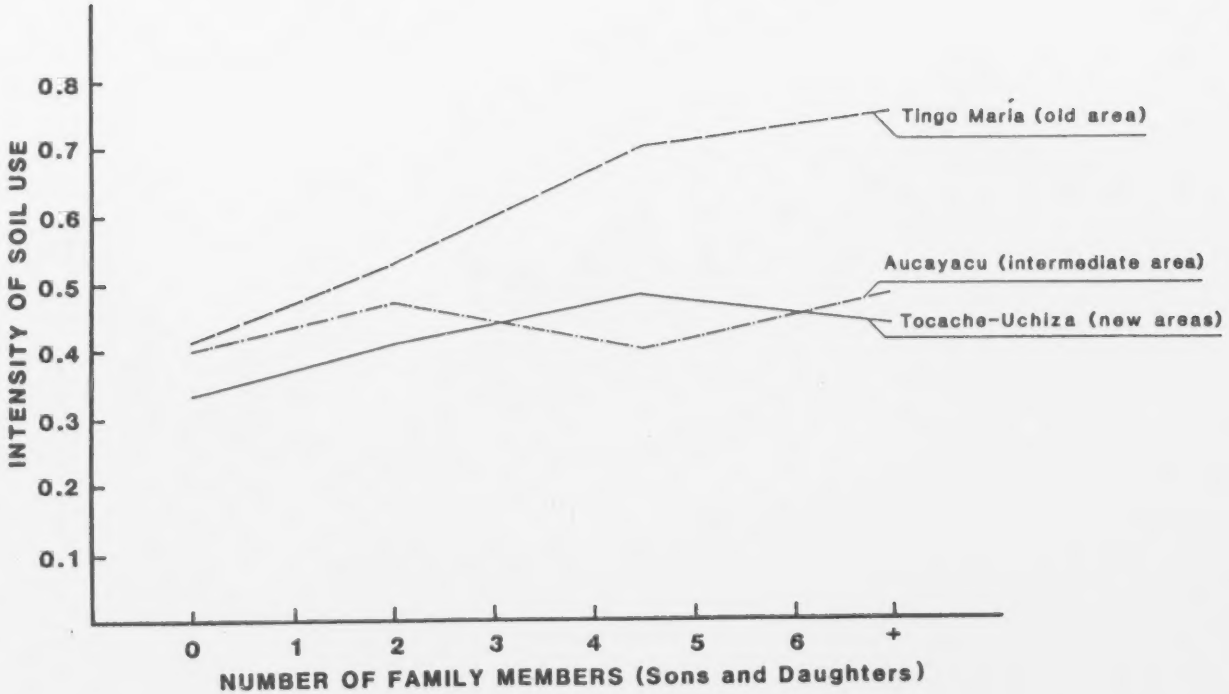

Fig.14.7 Intensity of Soil Use and Number of Family Members.

Tingo María, Aucayacu, and Tocache and Uchiza are very different for settlers from the highlands than they are for settlers from the eastern lowlands. Whereas highlanders' intensity indexes for the three regions are 0.60, 0.46, and 0.47 respectively, the jungle colonists' are 0.44, 0.33, and 0.34. Similarly, the former are much more involved in the market economy; they raise mostly permanent crops; and they usually have to face problems related to soil exhaustion after a number of years. Jungle colonists—former riverside inhabitants—develop more rational production systems: facing the fragile rainforest ecology, they have a tendency to settle on low lands, raise transitory crops for their own consumption, and remain only loosely articulated to the market economy. The differences parallel those between the adaptive system of *caboclos* (non-Indian peasants) and those of colonists coming from Brazilian regions on the Transamazonian highway, pointed out by Emilio Moran (1979).

Finally, we should consider ideological factors arising from a national government that pursues a policy of promoting lowland settlement and is reluctant to face agrarian problems in the highland regions where migrations originate. The government sees the Peruvian jungle as a territory open for settlement, where fertile lands for any kind of agriculture are abundant. In 1964, during Fernando Belaunde's first presidential term, studies carried out by the Ministry of Agriculture and the National Natural Resource Evaluation Office (ONERN) classified upper Huallaga as a region in which 51.2 percent of the soil had agricultural potential. This percentage is dramatically different from the results of studies carried out twenty years later, when colonization on tropical rainforest had proven to have serious limitations. Table 14.3 shows that in 1983 the ONERN study classified only 7.4 percent of lands as suitable for agriculture, while 58.3 percent was considered appropriate for forestry uses only. The contrast shows not only two different techniques for the study of soils, but more importantly, opposing ideologies. Marc Dourojeanni (1984) pointed out how the various soil studies in the upper jungle and Pichis Palcazu valley were similarly prejudiced and contradictory.

While the ideological reality thus prevails in state planning over the ecological, the environmental disturbances remain. The distorted judgment about the real number of cultivable hectares led in upper Huallaga to mismanagement of soils and improper intensive use of land.

Summary and Policy Recommendations

In brief, the process of intensification of land use in upper Huallaga is complicated by a series of endogenous and exogenous factors, as well as by some intermediate factors that result from the articulation of the colonists' subsistence economy with the market. Among the endogenous factors are family size, ethnic characteristics (highlanders or former jungle cultivators [*ribereños*]), the system of planting on steep slopes and/or in widely spaced rows, and peasant economic rationality, especially in the initial stages of colonization.

32-798 O - 90 - 5

Table 14.3 Soil Quality in Alto Huallaga According to Two Studies of Potential Use

	Ministry of Agriculture ONERN* (1964)	ONERN* Peñaherrera (1983)
	Percent	Percent
Intensive annual crops	35.64	5.7
Permanent crops	15.65	1.7
Pasture	37.72	12.4
Forest without agriculture value	10.99	21.9
Forest protection	-	58.3
	100.00	100.00

*ONERN is the National Office for Studies on Natural Resources (Oficina Nacional de Evaluación de Recursas Naturales).

Sources: Agreda 1984; Peñaherrera 1984.

As peasant production tends to evolve further into market-oriented agriculture, bringing modifications in economic behavior (toward greater intensification, for example), family labor allocation remains a significant factor of economic calculation.[12] In other words, although the portion of production dedicated to meeting consumption requirements declines, family size continues to be a crucial factor in economic decisions because settlers rely on labor rather than capital inputs. This seems to hold even for families who derive relatively large earnings from coca.

I prefer to conceptualize the colonists as peasants in transition, despite the high income generated by illegal coca cultivation. This implies that changes are necessary in extension and titling policy in such regions of agricultural frontier as the upper Huallaga. The size of plots granted to peasants must be determined according to family size and needs if the pattern of degradation, like that in Tingo María, is to be avoided.

In addition, there are exogenous factors, such as the increase in regional population density, the unequal exchange between the city and the country, soil quality, the legal system of land tenure, and a colonization ideology, that lead to irrational use of the land. Government policies for human settlement must include environmental management plans not only for rural

zones but also for urban areas, since intensification is also a result of a regional population increase.

Another factor that should regulate plot size is soil quality (see Moran in this volume). In terrains where agriculture can be more intensive, plot size could be smaller; on poor land, given the necessity of fallowing, plots should be larger. With regard to the legal system, formal recognition of the existence of shifting agriculture is imperative. Just as in the cities, where the reality of street vendors or informal family economics is often ignored, so in the jungle, the itinerant character of an important sector of colonists goes unrecognized (Dourojeanni 1984). This leads to the denial of credit, since the colonist lacks a certificate of possession or a land title. Yet in regions where shifting agriculture is abating there is a tendency toward intensification, heedless of the long-run consequences.

With regard to the ideological aspect, my technical recommendation is for more ecological training of professional agronomists in an effort to counteract the influence of university training, which is excessively oriented toward expensive, "green revolution" technology and intensive modern agricultural systems.

To complete my model of intensification leading to degradation, I include plot size and land management as factors in between exogenous and endogenous variables. The reduced size of plots, as a factor of intensification in situations like Tingo María, is the result of a dynamic land market created by the high value of coca. In other circumstances it results from the strategies of colonists, varying according to whether they are highlanders or lowlanders. While highlanders tend to have smaller plots—22.93 ha—which, in comparison to the size of their plots in the highlands seem to them a veritable estate (Shoemaker 1976), colonists of jungle origins manage larger plots—31.57 ha—because of their experience with more extensive use. However, while 23 ha could mean an immensity of land for the highlander, it also implies the beginning of the soil degradation process.

Finally, land management in the case of coca cultivation in zones of excessive slope is as much a result of highland custom—where such terrain is cultivated without major problems—as it is of the national economic context, which requires the peasant to cultivate lands that are not adequate for such use. It is not only coca cultivation that is at fault, however. As we have demonstrated, other annual and permanent crops—coffee, tea, cacao—are planted on lands of protected forest, although such lands are vital for stabilizing the soil. Therefore, credit granted in the Peruvian high jungle for agricultural purposes should be regulated according to the type of land the peasant holds. Likewise, land titles should not be granted for plots where the greatest part of the terrain is protection forest or for forestry use. The resulting forestry activity can have a double purpose: as a complement to agricultural activity, and as environmental education for the colonist.

Notes

1. I am grateful to Carlos Aramburú and INANDEP (Instituto Andino de Estudios de Población/Andean Institute of Population Studies) for permission to analyze the survey applied in upper Huallaga in 1981.

2. Upper jungle is the Spanish *selva alta*, a generally recognized ecological zone of the Peruvian tropical forest that lies between the eastern Andean slopes and the Amazon basin at an altitude of 400–800 meters above sea level.

3. The two Belaunde administrations (1963–1968 and 1980–1985) were characterized by an outstanding emphasis on colonization programs.

4. Yellow corn is *maíz amarillo duro* (hard yellow corn). Starchy corn is *maíz amilaceo*, a large grain, usually white corn.

5. Cocaine paste is *pasta basica*, an unrefined brown paste molded into 1 kg bricks for shipment to processing centers to be purified into white powder.

6. These migratory movements are reflected in the intercensus population growth rates: between 1940 and 1961, the Alto Huallaga population increased at an annual rate of 7.8 percent; between 1961 and 1972, 7.6 percent; and between 1972 and 1981, 4.5 percent. The last rate shows the start of overcrowding. At present Tingo María region shows clear signs of overcrowding.

7. Upper Mayo = Alto Mayo; lower Mayo = Bajo Mayo.

8. In addition, the clandestine nature of its production leads to economic instability for this crop.

9. The experimental station at Tulumayo, located in the upper Huallaga basin, demonstrated that a mixed cropping system yields overall returns per hectare that are superior to a monocropping system.

10. An additional example is given by comparing the average number of cultivated hectares and their respective intensities of large, usually more recently occupied, farms—30 hectares and more—with the smaller plots—less than 10 hectares. In the former, average size is 7.51 hectares and intensity 0.34. In the latter, average size is 4.11 hectares and intensity 0.64 (Bedoya 1986).

11. Other symptoms of soil degradation in Tingo María are the diminishing returns of annual crops such as corn, rice, and beans. In addition, crop performance in this area is considerably poorer than in Tocache and Uchiza, where yields are 30 percent or 50 percent higher, even though soil quality is similar (Aramburú et al. 1985).

12. In 95 percent of the cases surveyed, the principal activity of children of working age was work in the family plot.

References

Agreda, Víctor
1984 Frontera Agrícola y Demográfica en la Selva Alta. Lima, Perú: Instituto Nacional de Planificación.

Alvarez, Elena
1983 Política Económica y Agricultura en el Perú. Lima, Perú: Instituto de Estudios Peruanos.

Aramburú, Carlos
1980 Estudio Social de la Colonización Tingo María, Tocache y Campanilla. Lima, Perú: United States Agency for International Development (USAID).

1982 Expansión de la Frontera Agraria y Demográfica de la Selva Alta Peruana. *In* Colonización en la Amazonía. Lima, Perú: Centro de Investigación y Promoción Amazónica (CIPA).

Aramburú, Carlos, Javier Alvarado, and Eduardo Bedoya

1985 La Situación Actual del Crédito en el Alto Huallaga. Lima, Perú: USAID.

Bedoya, Eduardo

1981 La Destrucción del Equilibrio Ecológico en las Cooperativas del Alto Huallaga. Working Paper No. 1, Lima, Perú: CIPA.

1982a Colonizaciones en la Ceja de Selva através del Enganche: El Caso Saipai en Tingo María. *In* Colonización en la Amazonía. Lima, Perú: CIPA.

1982b Historia Económica de una Gran Propiedad en la Ceja de Selva: El Caso Saipai 1900-1970. Lima, Perú: USAID (Syracuse University).

1983 Tendencias en el Proceso Colonizador de la Selva Alta: Estudio de Siete Regiones. Labor Migrations Project. Lima, Perú: FNUAP/OIT/DGE (Fondo de las Naciones Unidas para Actividades en Materia de Población/Organización Internacional de Trabajo/Dirección General de Empleo, Ministerio de Trabajo) (United Nations Fund for Population Activities/International Labor Organization/Ministry of Labor).

1985 La Experiencia de Colonización en la Selva Alta del Perú: Racionalidad Económica y Ocupación del Espacio. Working Papers. Lima, Perú: INADE/APODESA (Instituto Nacional de Desarrollo/Apoyo a la Política de Desarrollo en la Selva Alta).

1986 Sistemas Agricolas en la Selva Alta. INADE/APODESA. Lima, Perú, forthcoming.

Boserup, Ester

1965 The Conditions of Agricultural Growth: The Economics of Agrarian Change under Population Pressure. Chicago, IL: Aldine.

1984 Población y Cambio Tecnológico. Madrid, Spain: Grijalbo Editores.

Caballero, José María

1981 La Economía Agraria de la Sierra Peruana. Lima, Perú: Instituto de Estudios Peruanos.

Camino, Alejandro

1984 La Colonización como Problemática Social. Lima, Perú: CIPA-CNP.

CENCIRA (Centro Nacional de Capacitación e Investigación para la Reforma Agraria/National Center for Agrarian Reform Research and Training)

1973 Diagnóstico Socio-Económico de la Colonización Tingo María–Tocache–Campanilla. Lima, Perú.

Chayanov, A.V.

1966 The Theory of Peasant Economy. Homewood, IL: Published for the American Economic Association by R. D. Irwin.

Dance, José

1979 Evaluación de los Recursos Forestales del Trópico Peruano. Lima, Perú: Universidad Nacional Agraria/CEPIC.

Dourojeanni, Marc

1981 Posibilidades para un Desarrollo Rural más Integral en el Huallaga Central—Bajo Mayo. Lima, Perú: Proyecto Especial Huallaga Central (Huallaga Central Special Project).

1984 Potencial y Uso de Recursos Naturales: Consideraciones Metodológicas. Lima, Perú: CIPA-CNP (Centro de Investigación y Promoción Amazónica—Consejo Nacional de Población).

Gonzales, Alberto
1983 Colonizaciones y Patrones de Asentamiento en el Alto Mayo. Labor Migrations Project. Lima, Perú: FNUAP/OIT/DGE.

Goodland, R. J. A.
1980 Environmental Ranking of Amazonian Development. *In* Land, People and Planning in Contemporary Amazonia. F. B. Barbira-Scazzocchio, ed. Cambridge, England: Cambridge University, Centre of Latin American Studies.

Hecht, Susanna
1984 Cattle Ranching in Amazonia: Political and Ecological Considerations. *In* Frontier Expansion in Amazonia. M. Schmink and C. H. Wood, eds. Gainesville, FL: University of Florida Press.

Lesevic, Bruno
1984 Dinámica Demográfica en la Selva Alta: 1940–1981. Lima, Perú: CIPA-CNP.

Malleux, Jorge
1975 Mapa Forestal del Perú. Lima, Perú: Universidad Nacional Agraria.

Martinez, Héctor
1977 El Saqueo y la Destrucción de los Ecosistemas Selváticos del Perú. *In* Amazonía Peruana, Vol. 1, No. 2. Lima, Perú: CAAAP (Centro Amazónico de Antropología y Aplicación Práctica).

Meggers, Betty J.
1971 Amazonia: Man and Culture in a Counterfeit Paradise. Chicago, IL: Aldine.

Moran, Emilio
1979 Strategies for Survival: Resource Use along the Transamazon Highway. Studies in Third World Societies 7:49–75.

Paredes, Peri
1983a Migraciones y Tecnología y Empleo—Agrícola. Lima, Perú: FNUAP/OIT/DGE.
1983b Población, Colonización y Sistemas—Productivos en el Alto Mayo. Lima, Perú: FNUAP/OIT/DGE.

Peñaherrera, Teddy
1984 Aprovechamiento de los Recursos Naturales en la Selva Alta. Lima, Perú: CIPA-CNP.

Recharte, Jorge
1982 Prosperidad y Pobreza en la Agricultura de la Ceja de Selva. El Valle de Chanchamayo. *In* Colonización en la Amazonía. Lima, Perú: CIPA.

Sanchez, Pedro, and S. W. Buol
1975 Soils of the Tropics and the World Food Crisis. Science 188:598–603.

Shoemaker, Robin
1976 Colonization and Urbanization in Peru: Empirical and Theoretical Perspective. *In* New Approaches to the Study of Migration. D. Uzzell and D. Guillet, eds. Rice University Studies, Vol. 62, No. 2.

Watters, R. F.
1971 La Agricultura Migratoria en America Latina. Cuadernos de Fomento Forestal No. 17. Rome: FAO.

APPENDIX VI.

Report of

The Second Conference of Non-Governmental Environmental Organizations

Lima, July 20-22, 1989

Carlos Ponce
Michael Valqui
Peruvian Foundation for the Conservation of Nature (FPCN)

The Environmental Impact and Eradication of Illegal Coca Cultivation

When it was proposed to use "Spike" for the massive eradication of illegal coca crops, many voices were raised in protest, voices that were never raised to protest illegal coca cultivation or its sequel, drug trafficking. This, perhaps, reflects the reaction of society in general: impotence before a power which seems to be invulnerable, that is capable of anything, that can corrupt anything. Or, perhaps, a pseudo-nationalism, open or masked, which tolerates drug trafficking because it believes, erroneously, that the dollars it brings in are the only hope for the Peruvian economy and cause damage only to the developed countries.

Only recently has the environmental problem that drug trafficking causes begun to worry conservationists. Despite all the problems that naturally come from trying to work in areas which are convulsed by drug trafficking and subversion, some studies have been carried out which focus on this very serious problem. Nonetheless, one should note that this year has seen practically no progress in these investigations.

We need to make a serious effort to use advanced technologies such as satellite imagery, and unite the capacities of different sectors to do our best to confront this environmental problem. With better knowledge our criteria for rejecting or adopting solutions such as "Spike" won't be strictly emotional, as originally appears to have been the case, but instead, technical.
Pressure from conservationists should be directed at finding alternative solutions; solutions that take into account the environmental problem. This involves shouldering a very uncomfortable responsibility.

History of the Expansion of Cultivation

Not translated

Chart 1

ESTIMATED INCREASE IN THE CULTIVATED AREA OF COCA IN PERU

Year	Coca fields in Peru (in hectares)		
	Legal	Illegal	Estimated Total
1964	16,360[1]	---	16,360[1]
1974	17,000	10,000	18,000[4]
1980	19,330[2]	71,000	90,000[4]
1986	17,913.7[3]	132,000	160,000[4]
1988	18,000	182,000	200,000[4]

1. CONESTCAR (1965)
2. Maletta and Makhlouf (1987)
3. ENACO (1986)
4. Gomero (1988); estimated

All other figures are extrapolations

Antecedents in the War Against Drug Trafficking and the Present Situation

The foundations for the war against the illegal sale of cocaine were set in the 1962 Single Geneva Convention on Drugs, in which a 25 year time frame was established for the elimination of illegal coca cultivation and limiting cultivation to production for industrial and scientific uses. It was thought that getting at the root of the problem -- that is the production of coca leaf -- would solve the problem of drug trafficking. This focus, which failed to take into account traditional consumption in the Andes, had little success. This has been demonstrated by the continued growth of drug consumption in the developed countries, most notably in the United States.

The Condor Operations, financed in part by the Peruvian Government, seized a total of 112,464 kilograms of drugs, 897,751 kilos of coca leaf, 23 airplanes, armament, 275,255 kilos of precursor chemicals, 203 vehicles, 93 radios, and 108 motors. They destroyed 183 clandestine air strips and 941 maceration pits; and resulted in the arrest of 1,342 people (Multisectorial Commission 1988). By any standard that is a pretty meager haul, despite the enormous effort that went into the operations.

The eradication of coca fields by CORAH, initially manually, and now using mechanical cutters, has grown in the manner shown in Table 2.

If we compare this data with the approximately 20,000 hectares (10%) of coca newly brought under cultivation each year, we can see that eradication is not going to solve the problem, especially if the program does not deal with the dispersion of the coca growers to new zones.

Last year there was a real flap when the public learned that the U.S. Department of State was seriously considering the use of "Spike" as a quick and definitive solution to the problem and that a small pilot experiment was already underway. The controversy grew when it became known that some 16 hectares of coca plants had already been treated experimentally with "Spike". Because of the incoherent and secretive way in which the Peruvian government managed the affair, it is not surprising that the reaction was negative and emotionally charged.

In general, the Peruvian government has not been coherent nor firm in dealing with drug trafficking -- we have only to look at the case of the fugitive congressman Del Pomar (accused of drug trafficking). This year Bolivia received $60 million from the U.S. and $17.5 million from the United Nations for coca reduction and crop substitution programs. The program was negotiated, with

Chart 2

ERADICATION OF COCA FIELDS FROM 1983 TO 1988

YEAR	COCA FIELDS (Ha).	SEEDBEDS (M^2)
1983	730.25	
1984	3,134.42	
1985	4,827.83	
1986	2,576.13	
1987	875.36	
1988	5,138.00	184.089
TOTAL	17,254.99	184.089

Source: Multi-sectoral Commission (1989)

courage and good sense, with the coca producers themselves. Peru, on the other hand, received only a little more than $8 million which was all budgeted to fund UMOPAR and the CORAH programs, i.e. repressive operations.

A new way of looking at the problem internationally came out of the International Convention against the Trafficking of Illegal Drugs and Psychotropic Substances, adopted in Vienna on December 19, 1988, whereby the thesis of coresponsibility among producer, transit and consumer countries was accepted. (Rumrrill 1989)

To better understand the desperation of the consumer countries we need to look at the amount of money which drug trafficking involves. The amount of coca leaf produced per hectare varies greatly, depending on the zone and the intensity of the cultivation. If we take as a base information given by the U.S. Department of State to Congress we come up with an average production of one ton of coca leaf per hectare. Marcelo (1987) claims that average production is 2,400 kg/Ha/year. If we accept the more conservative estimate of one metric ton per hectare we come up with 180,000 metric tons of coca leaf, which at $3 per kilo (Calmet 1986), gives us $540,000,000 for the coca growers. Calmet, estimated that the result was equivalent to 20% of Peru's agricultural GNP in 1986.

To provide a better idea of what this implies, we have to calculate the value of this coca leaf at the price paid by the consumer. 100 kilograms of leaf yields one kilogram of PBC or .33 kilograms of cocaine hydroclorate (Caceres 1983) Thus, Peru's crop of coca leaf would produce 600 tons of cocaine. At a price of $25,000 per kilo in New York (White 1989) we arrive at the fantastic sum of $15 billion spent last year by consumers in the developed countries. American police estimate that the quantity of cocaine which enters the U.S. is at least 400 metric tons and that half is for the American market (White 1989).

Diagnosis of the Environmental Impact of Illegal Coca Cultivation

Traditionally, when coca was grown to meet the demand of chewers and not for conversion into cocaine, it was carefully planted on terraces or in deep wells where it grew well without provoking serious damage to the soil which nourished it. The use of terraces and deep wells in association with other crops such as yuca and shade trees shows that the erosive character of the coca plant was well known to early Peruvians, and that they took the measures necessary to prevent it. (Dourojeanni 1988)

The coca bush requires well-drained soils, therefore it is usually planted on slopes, but it can prosper in degraded or eroded soils "better than any other crop." (Plowman 1984:80 cited by Camino 1989)

Chart 3

CHARACTERISTICS OF COCA CULTIVATION WHICH CAUSE ENVIRONMENTAL DAMAGES

When cultivation takes place	Implications
- In the ecosystems in the high and edge of jungle areas	Destruction of ecologically fragile areas results when lands vulnerable to rapid erosion are denuded for coca cultivation and then receive heavy tropical rains.
- In well drained lands	Coca is furrowed following slopes and erosion is increased.
- In places where slash and burn clearing of forests has taken place	The action of rain alone on exposed soil reduces biomass and causes greater erosion.
- Fields without terraces and in shallow depressions	Speeds the rate of erosion.
- Harvesting process includes defoliation of coca plants, elimination of shrubs, and tilling of soil 4 to 6 times per year	Re-exposes soil to direct impact of the rain and repeatedly increases rate of erosion.
-Excessive use of agricultural chemicals (herbicides, pesticides, and fertilizers)	Contaminates coca plants, as well as land and water supplies.

Source: Dourojeanni (1988) (modified)

Deforestation

Today the practices of our ancestors have been abandoned with terrible consequences. The coca growers, migrants from the Sierra and the coast, and some others whose crops have already been eradicated, slash and burn an immense extent of forest, frequently in zones where the soil is so poor that it should only be used for "protective forestry." This speeds up the deforestation of the jungle. Dourojeanni (1988) based on detailed studies by Aramburu and Bedoya (1986), Aramburu (1982) and Bedoya (1982, 1986) "which allow us to deduce precise patterns of land use in the Upper Huallaga", claim that "we can estimate without much risk that in all of the Amazon basin, the deforestation caused directly or indirectly by coca cultivation amounts to some 700,000 hectares since the coca boom began in the the 1970s. This represents about 10% of the total estimated deforestation of the Peruvian Amazon basin in this century, and the trend is on the rise." (Dourojeanni 1988)

Deforestation has grave environmental repercussions including: the loss of soils through insidious and violent erosion, extinction of genetic resources, alteration of the hydrological balance and floods, reduction of hydroelectrical potential, difficulties in river navigation, reduction of potential hydrobiological resources, shortage of wood and lumber, reduction in wildlife, etc. The burning of the hillsides causes air pollution which has global effects, the loss of nutrients and the destruction of topsoil. (Dourojeanni 1988)

Erosion

In addition to causing erosion through deforestation, coca growing aggravates the problem because it grows best on slopes where drainage is good and because manual and chemical weeding exposes the soil and results in the breakdown of topsoil. These characteristics make coca the most erosive crop grown in the Amazon.

Contamination

Another serious problem caused by the present form of coca cultivation is the use of herbicides for weed control, fungicides to control fungus and fungus-like diseases, and insecticides for the control of leaf cutting ants, leaf worms and trunk borers. Because small growers have the necessary capital -- the crop is paid for in advance -- they overuse these biocides (Ponce 1988). The use of excessive amounts of fertilizers, in order to increase yields also causes contamination problems.

Several studies reveal that coca growing absorbs the majority of the fertilizers and pesticides that are applied in the jungle. Both products contaminate the coca and the cocaine, and the residuals leach into the water where the contamination seriously affects hydrobiological resources throughout the food chain, ultimately affecting people who consume the fish and other organisms which survive. (Ponce 1988 cit a Dourojeanni 1986)

But the contamination caused by the production of cocaine paste is even greater. The large amount of chemical wastes which are flushed into rivers and streams seriously pollutes them from their very source.

According to Marcelo (1987) the procedures followed in the Upper Huallaga require 18 liters of kerosene, 10 liters of sulfuric acid, 5 kilograms of quick lime, 1 kilogram of carbides, and 5 kilos of toilet paper for every 120 kilos of coca leaf to be macerated, and 1 kilo of acetone and 1 liter of toluene to wash every kilo of cocaine paste.

The wastes from this process are thrown into the watercourses where they severely affect the organisms which live in them. Kerosene reduces the availability of oxygen and produces chronic toxicity; sulfuric acid is highly corrosive, toxic and irritating; the carbides and quick lime are toxic and help to raise the PH level of the water; and toluene and acetone are dangerous if ingested, inhaled or absorbed through the skin.

In the rivers and streams that criss-cross the zone where the maceration of coca leaves takes place many species of fish, reptiles, crustaceans, etc have disappeared because of the high concentrations of toxic chemicals. (Marcelo 1989)

This contamination by necessity pours into the river beds and into the food chain, especially if you consider the amount of coca leaf that is processed. Taking Marcelo's estimates (1986) the amount of chemicals dumped into the rivers annually amounts to some 57 million liters of kerosene, 32 million liters of sulfuric acid, 16 metric tons of quick lime, 3,200 metric tons of carbides, 16 metric tons of toilet paper, 6.4 metric tons of acetone, and 6.4 million liters of toluene. These estimates are based on the transformation of 2,400 kilos of leaf annually multiplied by the 160,000 hectares which were thought to be under cultivation in 1986. A summary of the most serious effects is shown in Table 4.

Other Environmental Effects

Coca cultivation also damages the environment in less obvious, although still serious, ways. According to Camino (1989), "the

Chart 4

EFFECTS OF ILLEGAL CULTIVATION OF COCA AND ITS IMPACT ON THE ENVIRONMENT

1.	DEFORESTATION	Erosion due to increased water effects Erosion due to sudden water action Loss of hydroelectric potential Flooding of lower valleys Sedimentation of rivers and ports Reduction of the hydrobiological potential Loss of genetic resources Loss of firewood, wild flora, wood, and fauna habitats
2.	EROSION	Contamination of waters with sediments Loss of soils Increased furrowing Reduction of potential uses of soil. Desertification
3.	WATER CONTAMINATION	Death of aquatic organisms Alteration of the ecosystem Contamination of drinking water Reduced quality of waters for irrigation Poisoning of human users

cultivation and traditional use of the coca leaf is a vital element in the complicated pattern of the Andean resident's adaptation to his particular surroundings. A diversion of the supply of coca leaf from traditional use to the more profitable narcotics traffic causes an integral impact on the community and the region in which it resides. The scarcity of coca leaf generates an immediate shortage of funds, restricting access to food that was previously obtained through trade; it also pushes people toward a money economy, which in turn forces them more and more into the illegal cultivation of coca." The economic dynamic generated by narcotics traffic stimulates the migration from the countryside to the city and reduces the population of the Sierra, which in turn reduces food production, raising of livestock, and other activities that represent the more rational use of resources. (Camino 1989).

There is also convincing evidence of complicity among the coca growers, guerrilla groups, and narcotics traffickers. The inability of the Peruvian government to govern or even maintain a presence in the jungle regions, combined with the growing presence of drug traffickers, has produced fertile ground for the acceptance of the Shining Path and MRTA by the local residents. These groups have organized the coca growers and protected them from the abuses of the drug traffickers and corrupt elements of the police. The traffickers now pay for the harvests in advance, they pay the guerrillas a tax, and they all work to force out any government presence.

Under these conditions, eradication and development are doomed to falure; it is no longer possible to speak of controlling forest harvesting or the rational management of animal life. Furthermore, several national reserves have been invaded by coca growers. The Tingo Maria National Park is completely overrun, there are coca fields in the eastern region of the Abiseo River National Park, and the Cutervo, Yanachaga-Chemillen and Manu parks have been invaded to some extent.

Suggestions on how to Going About Finding a Solution to the Problem

In order to solve the problem of drug trafficking all countries that are involved, whether as producers, transit points or consumers are going to have to accept some of the responsibility and contribute as much as they reasonably can. This was the basis of the Vienna International Convention. During the convention, the countries affected accepted shared responsibility and established the legal mechanisms for the confiscation of property derived from drug trafficking, the suspension of bank confidentiality, and the interdiction of boats and planes suspected of transporting drugs.

But according to Lamas, cited by Rumrrill (1989), the accord only focus on the repressive aspects of the problem. It does not touch on the problem of poverty, which pushes the campesino into coca cultivation in the first place. This social focus needs to be analyzed and the causes which underlie drug trafficking need to be resolved. We must assure just, and not repressive, treatment for the coca growing campesino. We must differentiate between those who grow coca out of necessity -- those who grow it as their only alternative to starvation -- and those who grow it because it is the most lucrative alternative. The fight against drug trafficking should, therefore, contemplate the development of the areas succeptible to immigration, as are the Sierra and, finally, the coast (Ponce 1989). If we do not achieve social justice our gains are going to be small and perishable.

Something that has to change internationally is the ambiguity with which consumption is treated. On the one hand it is satanized, and on the other it is tolerated. The influx of drug dollars into the economies of producing countries does not justify passivity on the part of their governments, especially since drug use is also taking place within their urban areas, creating a climate of violence and insecurity. Besides, this influx of dollars "...plays a decisive role in the indexation of reserves...and tends to worsen hyperinflation." (Andean Commission of Jurists 1989)

In Peru the Multisectorial Commission organized by the Ministry of the Interior is charged with finding alternative methods for the eradication of illicit coca crops and the problems of contamination that drug production causes. The Commission is producing studies on illicit drug trafficking and on drug addiction, which seem to suggest that policy changes are possible. We cannot focus solely on repressive measures. We must also take into account development, education and prevention in sectors as varied as agriculture, industry, transportation, health and education.

Interesting alternatives such as having the U.S. buy up the production of coca leaf for a period of time, which was proposed by Kausachum (1986), are overly optimistic and others, such as the "final solution" of using "Spike" are too simplistic. The solution is neither simple nor quick; instead it is going to take a collection of decisions and actions on many levels, it is going to take a long time to mature, and it is going to require a lot of money and cost many lives, given the predictably violent reaction of the drug traffickers.

Corruption and death threats are going to be serious problems, given the receptivity of the authorities to the large sums offered and the realistic possibility that authorities who do not cooperate will be assassinated. It is crucial that we maintain the element of surprise and that we make allowances for personal and family security (White 1989).

One coherent strategy which may help to resolve these deeply rooted problems is that proposed by Brack (no date), Dourojeanni (1988), Rumrrill (1989) and Verdera (1989), among others. Starting from the assumption that the causes for the increase in coca cultivation are economic -- they are to be found in some cases in the lack of alternatives which forces many to plant coca, in other cases in an avaricious desire for riches -- one reaches the conclusion that growing coca has to be made unprofitable relative to other crops, so that the substitution of crops will become automatic and voluntary. We must try to break the "incremental cycle" which rules drug trafficking. Such powerful persuaders as corruption, assassination, and misery create an economic climate which favors its own growth and makes it difficult for any activity which doesn't favor its growth to survive.

This strategy needs to be accompanied by a long-term political strategy, a real state presence in coca growing zones, and a firm and coherent government capable of negotiating as an equal with the countries of the North, which will of necessity have to provide the economic resources that, according to Malpica (1986) and others, will be at least $1 billion a year.

Repressive Action

In Tables 5 and 6 we list the conditions that must be present for a successful war against illegal coca growing, and we outline some actions that must be given priority.

Given the lack of a government presence in the coca zones, repression is going to have to be the first step, but repressive measures should not be directed against the growers of coca leaf. Instead, the production of coca paste and cocaine hydroclorate, the trafficking and selling of the product, the entry of narco-dollars into the legal economy, the punishment of the drug traffickers and corrupt officials, and impeding new illegal cultivation, should be our prime targets.

The production of cocaine requires large quantities of ingredients that are easily controllable because their production is highly centralized. The volume of precursor chemicals which is needed is so large that it is impossible to transport it by air from other countries and its sale, as well as the access roads, can be controlled without great difficulty (Verdera 1989). What is needed is to monitor the movement of precursor chemicals using uncorruptible and well armed officials posted on access highways.

The transport of the drug out of the area can also be controlled by Condor-type operations, through the detection and destruction of clandestine air strips and the detection of land transport, etc.

Chart 5

ILLEGAL CULTIVATION OF COCA: BASIC CONDITIONS FOR FIGHTING IT

1. DEVELOP A CLEAR SOCIAL VIEW OF THE SOLUTION.

2. DETERMINE THE CO-RESPONSIBILITY OF THE COUNTRIES INVOLVED.

3 COORDINATE STRATEGY TO ACHIEVE COHERENT NATIONAL AND INTERNATIONAL PLANNING.

4. REVIVE THE PRESENCE AND ACTION OF THE PERUVIAN GOVERNMENT IN THE RELEVANT AREAS.

5. SECURE COHERENT GOVERNMENT EXECUTION OF THE DESIGNED STRATEGY.

6. STRUGGLE CONTINUOSLY AGAINST CORRUPTION.

7. DISCOURAGE THE USE OF DRUGS.

Chart 6

ILLEGAL CULTIVATION OF COCA: MAIN LINES OF ACTION IN PERU

REPRESSIVE ACTION:

- CONTROL THE INPUT OF RAW MATERIALS.
- SEARCH AND ELIMINATE ILLEGAL LABORATORIES AND AIRPORTS.
- CONTROL AIR TRAFFIC.
- FIGHT ALL THE LINKS IN THE MARKETING CHAIN WITHIN THE COUNTRY.
- IMPEDE THE LAUNDERING OF NARCODOLLARS.
- SEVERILY PUNISH NARCOTRAFFICKERS AND CORRUPT AUTHORITIES.

PREVENTIVE ACTION:

- DEVELOP REGIONS SUBJECT TO MIGRATION.
- IMPEDE THE GROWING OF NEW COCA PLANTS.
- FINANCE AND FACILITATE CULTIVATION OF SUBSTITUTE CROPS.
- TRY TO CHANGE VALUES THROUGH EDUCATION.
- PROVIDE SECURITY FOR PUBLIC AUTHORITIES, DEVELOPMENT WORKERS AND FARMERS

EXPECTED RESULTS:

- REDUCE THE ILLEGAL AREAS OF COCA CULTIVATION:
  1. BY SUBSTITUTION
  2. BY ERADICATION
- DIMINISH NARCOTICS TRAFFIC

In the cities the sale of the drug must be controlled. This will require the monitoring of users and the areas that they frequent.

Stopping narco-dollars from getting into the formal economy means first and foremost repealing recent laws, like the 1988 decrees which allow the use of "parallel" markets for dollars and the repatriation of dollars deposited overseas with no questions asked. There must also be a realistic exchange policy, which would eliminate the informal market for dollars which in December of 1988 accounted for 80% of all currency exchange in the country. (Andean Commission of Jurists 1989)

Corrupt authorities and drug traffickers must be tried and punished. That will require the imposition of a state of law in all areas of the country, a set of coherent drug laws, coordination between the police and the courts, morally strong authorities and good security (so that we don't lose the few morally strong authorities that we seem to have left).

We are going to have to ensure that new areas of coca cultivation are not opened up, especially in remote zones or beneath the jungle canopy where they will not be detectable by air. This implies air control, patrolling of existing highways in areas from which migration might take place, of waterways, etc. In addition, plans for new roads should be studied carefully and the construction of forest roads should be controlled to assure that the state and the cooperatives do not inadvertently support the drug traffickers.

Eradication and Crop Substitution for Coca Fields

Taking the profit out of the growing of coca, which we mentioned earlier, will cause the abandonment of many remote areas and will cause a flow of migrants toward more accessible zones where there is better infrastructure, or into the cities and other urban centers. For those fields that have been abandoned we should think about economic ways of eradication. One possibility is the use of agricultural chemicals. In these zones we need to reestablish the ground cover, either by reforestation or through natural regeneration. This cost, as well as the cost of eradication, should be assumed by the state or by the international community.

In areas where there will probably be a continued campesino presence the strategy should consider the substitution of profitable crops in areas where that is possible, or by forest species in the areas which are most vulnerable. The eradication will be done either manually or mechanically by the campesinos themselves, with the help of the state. In no case should it require any more effort than it took to cut and burn the jungle to establish the field in the first place.

This policy of eradication and substitution should avoid repression of the campesinos. To the contrary, the state should create a legal structure where tranquility and peace can reign, and it should guarantee stable markets for legal products.

Incentives for Crop Substitution

The substitution of other crops for coca should begin with an educational campaign about the alternative crops and an effort to teach the campesinos the necessary technology. Crop substitution will only be possible when stable, permanent markets for the products, guaranteed by the state and funded in coordination with the consumer countries, are available.

The inputs needed by the farmers should be available and, if necessary, subsidized, with whatever control is needed to avoid the contraband sale of those products to other areas or out of the country.

Conclusions

1. Drug trafficking causes damage at both the national and international level and is a threat to the societies affected by it. Therefore, the fight against drug trafficking should be the responsibility of the countries where drugs are consumed, produced or transshipped, with each contributing according to its economic possibilities. A coherent and long-range strategy is needed which should include financial assistance from the user countries to the producers.

2. In addition to the damage caused by drug trafficking to society, one of the consequences of the illegal cultivation of coca and the production of PBC and cocaine hydrochloride in Peru, Bolivia and Colombia is irreparable damage to the environment caused by deforestation, erosion, and contamination of a large part of very fragile ecosystems. The amount of damage being done is growing because of the rapid growth of the amount of land under cultivation and the lack of government control in the coca growing zones.

3. In the countries where coca leaf is grown, and especially in Peru and Bolivia, the most important cause of the growth in production is socio-economic. This crop is often the only alternative the campesinos have to grinding poverty, and it provokes migration from the depressed areas to the coca growing areas. Any strategy to combat drug trafficking should give priority to bettering the standard of living of the people in the depressed areas.

4. Given the serious environmental damage that the illegal coca cultivation is causing it is important and desirable that private conservation, environmental and ecological organizations put pressure on their governments to seek a solution to the problem by conducting research on the environmental impact of the drug industry and by supporting the transfer of new technologies which will make crop substitution and development of the depressed areas possible.

APPENDIX VII.

VICTIMS OF THE DRUG TRADE
Peru's jungle rivers are being contaminated with vast quantities of toxic waste and pollution

By Buenaventura Marcelo T.
National Agrarian University

Life began in water and water is essential to life. It is the basis of the cell structure of all living organisms, and it is one of the most valuable and appreciated resources available to the human race.

Rivers and their water represent the lifeblood of the biosphere. Water abounds in the Peruvian Amazon basin. But since 1970, due to narcotics trafficking, the rivers and streams of the middle and higher elevations of the Upper Huallaga Valley -- between the provinces of Leoncio Prado (Huanuco), Tocache, and Mariscal Caceres (San Martin) -- have literally been flooded, year after year, with vast quantities of toxic waste and pollution. In 1986, the volume of these substances was estimated at 57 million liters of kerosene, 32 million liters of sulphuric acid, 16 thousand metric tons of lime, 3,200 metric tons of carbide, 16 thousand metric tons of toilet paper, 6.4 million liters of acetone, and 6.4 million liters of toluene.

These figures are based on realistic estimates of the area under coca (Erythroxylum sp.) cultivation in the region. Average annual production of dried coca leaf is calculated at 2,400 kilos or 200 "arrobas" (an arroba is more or less 25 pounds) per hectare (based on 40 arrobas per harvest and 5 harvests per year). The volumes of chemicals and other materials listed above reflect estimates of the quantity of precursors needed for the maceration of coca leaf (to produce basic paste) and the subsequent washing of the paste to produce cocaine base (the intermediate phase in the manufacture of cocaine hydrochloride). The production of basic paste for 1986 is realistically estimated at some 6,400 MT.

Kerosene is an oily liquid with a pungent odor, whose molecular formation is basically a long chain of hydrocarbons, which is obtained by distilling petroleum. While it is true that kerosene is only moderately toxic to living organisms, its long-term presence in the water has severe consequences for fish and amphibians, not only because it reduces dissolved oxygen levels in the water, but also because its ingestion or inhalation produces chronic ill effects.

Sulphuric acid (H_2SO_4), generally derived from sulphur, pyrite, sulphuric gases, etc., is a highly corrosive, toxic, and irritating oily liquid that severely damages and often burns organic tissue. Furthermore, since it dissolves easily and in high proportions in water, the fish, amphibians, and flora in those rivers affected by the drug trade cannot avoid acute or chronic sulfuric acid poisoning.

When dissolved in water, chemicals such as carbide or calcium carbide ($CaCO_2$), calcium carbonate or calcic carbonate ($CaCO_3$), and quicklime or simply lime (CaO), in addition to being highly toxic to organic tissue, raise the water's pH to levels which the flora and fauna cannot withstand. Toxins like acetone (CH_3COH_3: dimetylcetone, 2 propanone) and toluene or methylbenzene, which are highly soluble in water and extremely toxic, are especially dangerous for fish and amphibians through ingestion, inhalation or cutaneous absorption.

Year after year, the residues of these toxic substances are dumped into the Upper Huallaga's rivers and streams, particularly the latter, since maceration pits are generally built alongside running water. The result can only be a grave threat to the survival of the region's rich aquatic resources.

Dangerous Levels of Deoxygenation

The sulphur released from sulphuric acid has an irreversible effect on plant and animal life. Acidic toxins are very harmful for living organisms, not only because they accumulate in organic tissue, but also because high concentrations of these contaminants dangerously lower dissolved oxygen levels in water.

Most aquatic organisms cannot survive in deoxygenated rivers or lakes. As dissolved oxygen levels are reduced, fish must pass greater volumes of water through their gills in order to obtain the oxygen they need to survive. Yet as the contaminated water moves through their gills, they also absorb the toxic substances contained in it. In other words, the less oxygen there is in the water, the more pollutants the fish ingest to accumulate in tissues and vital organs.

The presence of high concentrations of these substances greatly reduces the natural self-regulating ability of small and mid-sized rivers, provoking abrupt changes in the waters' pH levels from very acid to very basic and vice versa. This phenomenon severely impacts aquatic life. The tendency of the toxins to damage the vital organs of plants and animals (in the latter case, causing lesions of the liver, heart, kidneys, brain, etc.) can also lead to grave genetic mutations. In addition, a drastic reduction in the amount of oxygen in the water can kill off existing phyto- and zooplankton, which, as aerobic bacteria, play an important role in the natural purification of water. As they disappear, they are replaced by anaerobic bacteria that contribute to biological contamination of the Amazon waterways by microorganisms such as sulphuric bacteria and others.

Today, the contamination of these rivers already exceeds pollution standards established by the World Health Organization for fresh and inland water, which designate as polluted or contaminated those bodies of water which have been altered in such a manner that they can no longer be put to the normal uses which would correspond to their natural state (WHO, 1961).

Fish Disappear

Many species of fish, amphibians, aquatic reptiles, and crustaceans have already completely disappeared from the rivers and streams in areas where maceration pits are located. Most noticeably, the "caracha" (Bryconamericus sp.), "bagres" (Pygidium sp.), and the "carachama" (Ancistrus sp.) have

disappeared, and a similar process is occurring with the vegetation. At the same time, a species of algae locally known as "sorropa" (Cladaphora sp.), which is the primary food source for many fish and amphibians, is proliferating. The overabundance of this algae is convincing proof that the trophic chain has been broken. The primary level (green plants) of the food chain may be the most obviously affected, but the secondary level (herbivorous animals such as fish, amphibians, and reptiles) is also impacted, a fact which will no doubt have repercussions throughout the ecosystem.

The ongoing dumping of an ever-increasing volume of waste products from the coca industry into these rivers is highly alarming. Moreover, coca cultivation is expanding at an astounding pace: 18,000 hectares in 1974; 90,000 in 1980, and 160,000 in 1986. This implies an annual growth rate of approximately 31% for 1974-1980 and 10% for 1981-1986 -- rates unequalled by any other food or industrial crop in Peruvian history.

Only 0.3 percent of the coca grown in the Upper Huallaga Valley is "legal", that is, authorized by the government before Legislative Decree 22095 was signed in early 1978. From that date until 1986 (9 years), the total area planted in coca in the Upper Huallaga increased by 95,000 hectares, despite the fact that the decree both prohibited the cultivation of new coca fields and ordered the eradication of existing crops within two to three years.

Strange as it may seem, however, as of 1980 the government itself, through the joint action of the Upper Huallaga Special Project (PEAH) and the Ministry of Agriculture, began to legalize clandestine plantations: first, by qualifying farmers to legally own their land even though they had illegally grown coca; and second, by later granting them the contracts formalizing their ownership of the land.

But the plants and animals that inhabit these rivers do not face the death threat of the drug trade's industrial waste alone. The health of the human population, as well as that of domestic animals, is also in danger, since the lack of an adequate supply of potable water drives them to drink the contaminated waters of the rivers and streams. Today, over 150 streams and small to medium-sized rivers have in some way been polluted.

It is highly unsettling that both government officials and the people of the Upper Huallaga are completely ignorant of the treacherous environmental pollution that is being caused by narcotics trafficking. The community must be alerted to these dangers in order to avoid the further spread of coca cultivation throughout the country.

* * * * * *

ADELAIDE • AMSTERDAM • ANCHORAGE • AUCKLAND • BOSTON • BRUSSELS • BUENOS AIRES • CHICAGO • COPENHAGEN • DUBLIN
FORT LAUDERDALE • GOTHENBERG • HAMBURG • LEWES — U.K. • LONDON • LUXEMBOURG • MADRID • MONTREAL • OSLO • PALMA DE MALLORCA
PARIS • ROME • SAN FRANCISCO • SAN JOSE — COSTA RICA • SEATTLE • STOCKHOLM • SYDNEY • TORONTO • VANCOUVER • VIENNA
WASHINGTON • WORLD PARK BASE — ANTARCTICA • ZURICH

GREENPEACE

Greenpeace USA • 1436 U Street NW • Washington DC 20009 • Tel (202) 462-1177
Tlx 89-2359 • Fax (202) 462-4507

APPENDIX VIII.

BRIEFING PAPER

STATE DEPARTMENT'S COCA ERADICATION SPRAY PROGRAM IN PERU

The U.S. State Department Bureau for International Narcotics Matters (INM) is planning to spray herbicides in the Huallaga Valley of Peru to eradicate coca. Below I have outlined the issue and have provided a brief summary of the three pesticides considered for use, with the focus on the leading candidate, tebuthiuron.

Background on the Proposed Coca Eradication Project

The U.S. State Department's Bureau of International Narcotics Matters is in the final stages of initiating a coca eradication campaign in Peru as part of the Administration's "War on Drugs." According to current sources, State has purchased approximately $10,000 dollars worth of the herbicide tebuthiuron (Spike) from Elanco Products (Division of Eli Lilly and Co.). Another $90,000 (approximately) was envisaged, but was canceled May 23, 1988 when Eli Lilly decided to discontinue selling the product to State. The total guesstimate of the cost of the program over the planned three year life of the program would be approximately $25 million.

Greenpeace, as well as numerous other environmental organizations, is concerned that in the State Department's haste to eradicate the drug, the agency is ignoring numerous issues concerning the potential devastating impact of the herbicide on the environment and the area's inhabitants. In initiating the program, the State Department commissioned an Environmental Assessment (EA) that leaves major gaps in our knowledge of the potential impact of the proposed 100 square mile project (Labat-Anderson, "Environmental Assessment of the Use of Herbicides to Eradicate Illicit Coca Overseas," November 30, 1987). Such a review is required under the National Environmental Policy Act (NEPA) and Executive Order 12114.

Furthermore, the State Department neglected to consult directly with Congress, pertinent federal agencies such as the Environmental Protection Agency, the Council on Environmental Quality and the American and Peruvian people in developing its plan. The Peruvian government has, of course, been alerted and

is calling for increased international review. Should Peru decide to allow INM to take action in Peru, INM plans to file a "finding of no significant impact" as a result of doing its EA despite the fact that such a finding is patently false as described below.

Due in part to adverse publicity in their hometown of Indianapolis, Eli Lilly, the parent company of Elanco which produces the tebuthiuron, May 23, 1988 withdrew its contract with State for a remaining $90,000 worth of the product. In response, the State Department reportedly wants to purchase the patent rights to tebuthiuron and is negotiating with Eli Lilly. Due to the dispute over the use of tebuthiuron, the program has been thrown into a lurch with the State Department believing that no other pesticide is as effective against coca.

General Problems with the EA

At no point in the EA are differing program options detailed. In fact, no specific plan of action is laid out for public review at all.

Description of Peruvian climes do not indicate the location of the sites to be sprayed. There are different concerns for different areas, e.g. the same program would have different repercussions in tropical forests versus more open lands.

There is no discussion in the entire document as to the potential impact of any spraying on the ecosystem of the area, including the impact on plant and animal species, many of which have not yet been identified. In fact, according to the State Department, Peru has no Endangered Species listing. Only now is a naturalist studying the flora and fauna of the region. Both tebuthiuron and hexazinone, the second pesticide option (see below), are listed by the U.S. Department of the Interior Fish and Wildlife Service as having the potential to impact Endangered Species (Opinion on the Pesticide Cluster Review for Rangeland Pesticides, December 11, 1984). The EPA Office of Endangered Species maintains that all herbicides have the potential to adversely impact plant species, unless expressly proven not to.

No detailed description is provided of the costs and benefits of the program. As such, neither the regulatory officials nor the public can determine the cost efficacy of the program and also determine why it would be more effective than improving border controls and public education or any other plan of action that the Administration may have developed.

A further problem is the misconception that eradication of any crop can be achieved. It has been demonstrated with other U.S. spray programs that eradication is impossible to carry out

and suppression is all that can be hoped for. Furthermore, such efforts would most likely result in growers simply moving to other areas which they would slash and burn in order to set up production there. Thus, INM has to consider whether suppression is enough to warrant a multi-million dollar plan.

Although the U.S. Drug Enforcement Agency has been conducting drug-related actions for years, primarily concerning marijuana, the Agency has never formally considered the use of tebuthiuron as a part of national drug control efforts or announced the use of it for the public to debate. We believe that public input is integral to any federal program that could have a significant impact on the environment.

Analysis of the Environmental Assessment:

The following analysis of the EA focuses on the program vis a vis the proposed use of tebuthiuron.

Impacts on Humans:

The EA presents the health effects analysis in such a tone as to imply that the herbicide poses no significant health problems. The truth of the matter is that the data base is missing numerous key short and long-term health studies including studies on the chemical's ability to cause general chronic effects, cancer, birth defects and genetic damage. The document neglects mentioning that the chemical is very similar to three related herbicides, monuron, diuron and linuron. All of these chemicals are known to cause "urogenital problems," including kidney, bladder and testicular tumors. Furthermore, the product has been found in the milk of lactating laboratory rats.

Impacts on Wildlife:

The EA only describes the presence of wildlife known to be in South America in general, not specifically in the areas to be treated. As mentioned above, the presence of species specific to the Huallaga Valley is only now being studied.

In the case of impacts on wildlife, there are more data gaps. There is also concern that birds may mistake the pellets for seed and be harmed.

Impacts on the environment:

To make things easy, State is ready to claim that their research has resulted in findings of no significant environmental impact. This cannot be allowed to be held true. Tebuthiuron is a broadleaf herbicide capable of killing all broadleaf plants it contacts. This action can have long-term implications as the

herbicide has been found to persist in the soil up to five years.

During this time grasses are able to grow back at least in some areas, which under the best scenario would help contain erosion. Erosion could have a devastating impact on the Amazon River, into which tributaries from the sprayed areas flow. As mentioned, re-growth of treated areas occurs through the growing of grasses, not the numerous hardwoods and other broadleaf plants, including staple food crops such as corn, bananas and beans. This could lead to degeneration of the tropical forest, potentially attracting cattle ranching. Ranching can have devastating impacts on the soil in sensitive areas.

Analysis of EPA Review Information:

In analyzing EPA's review of the herbicide, conducted as part of the Agency's on-going pesticide re-registration program, we note that there are numerous fundamental data gaps in the pesticide's registration document. These are described in EPA's July, 1987 review document "Guidance for the Reregistration of Pesticide Products Containing Tebuthiuron as the Active Ingredient" and area outlined below:

What we don't know:

Human Health Effect Questions:

No acceptable studies are available on the chemical's capacity to cause cancer, and further studies are required concerning birth defects, mutagenicity and chronic toxicity.
No valid studies are available assessing the acute oral and dermal toxicity.
No U.S. tolerances exist for tebuthiuron residues on common food crops since the chemical is not registered for food uses in the U.S. However, in Peru, coca and food crops are grown together. These food crops include the staples of the peasants' diets -- bananas, beans and corn.

The data base of the chemical's acute and chronic health effects is full of gaps that must be conducted for continued registration. EPA has requested five further studies on acute toxicity and seven long-term studies concerning the chemical's ability to cause cancer, chronic toxicity, birth defects, genetic damage and metabolism problems. These studies will take from one to 3 1/2 years to complete and another several years for the Agency to review.

Environmental Impact Questions:

Dietary data for birds is incomplete.
No studies exist on the impact to amphibians.

Data is lacking on the long-term availability of tebuthiuron for run-off into aquatic systems and the likelihood of its long-term build-up in the soil.
Further studies have been requested on tebuthiuron's ability to contaminate groundwater.
No data is available on non-target insects potentially impacted by foliar spraying, including insects native to Peru.
No studies have been completed on the potential for tremendous erosion problems. Numerous streams flow from the valley into the headwaters of the Amazon River.

This data base, too, is plagued by data gaps. EPA has requested at least 21 further tests to determine the impact of the chemical on the environment and ecology. All in all, according to EPA's Product Manager, no studies are available to EPA that have been conducted in Peru's tropical clime (Eli Lilly states that it has conducted no studies of the product in such an environment). These studies are particularly important when considering the variety and sensitivity of the types of native vegetation and wildlife.

<u>What we do know:</u>

Human Health Effect Questions:

Tebuthiuron, a member of the class of substituted dimethylurea compounds, is structurally similar to other compounds in the family that are known to impact the urogenital tissues of laboratory animals. For instance, tests on laboratory animals show that monuron causes both kidney and bladder tumors and that diuron causes bladder tumors. Linuron, a substituted monomethylurea compound, causes testicular and interstitial-cell tumors.
Studies conducted to date indicate the chemical affects the liver and kidney.
Tebuthiuron and/or its metabolites has been found in the milk of lactating laboratory test rats.

Environmental Impact Questions:

Tebuthiuron is persistent in soil and water. In one study, there was no significant degradation in water after two months. The chemical has a half-life in soil from 11 to 61 months (five years).
Tebuthiuron is considered mobile to very mobile in soil, and can leach through a soils and contaminate groundwater. It has already been found in shallow groundwater in Texas.
Tebuthiuron can kill any broadleaf plant. As such, not only will all coca plants be impacted, but also the

area's food crops and trees. This can not only lead to starvation of the area's inhabitants, but also the mass erosion of the area's topsoil. Indiana has reportedly witnessed treated areas remaining completely bare for two to five years after application. Treated hillsides have resulted in the formation of gullies.

Erosion, in turn, can impact in at least three ways: one is that it allows for the persistent herbicide to be carried downstream where it could possibly be pulled into irrigation and drinking water sources. It can also result in severe siltation downstream. Siltation not only can have an impact on the area's drinking water, but also reduce the number of fish in the area, a primary source of protein and natural insect control. The fish can also be affected by the herbicide killing the natural vegetation in the river that the fish depend on.

Aerial application could result in inconsistently applied rates and aerial drift, potentially impacting off-target areas.

Application could impact endangered species: As noted in EPA's Registration Standard, tebuthiuron "will pose a hazard to endangered and threatened plant species." While this opinion was based on concern over exposure to the environment in the U.S., Greenpeace is concerned that the chemical may have severe impacts on the fragile environment of the tropics with its great species diversity. Since so many of the plant and animal species in the area have yet to be identified, and, in the past have been used as the foundation of modern medicine and other items, Greenpeace is concerned over the potential loss of biological diversity.

Below, I have provided short analyses of the registration status of hexazinone (Velpar) and trichlopyr (Garlon), the two other herbicides of choice. These I have taken from articles in the newsletter "Pesticides and You." Apparently, the U.S. Department of Agriculture is also experimenting with an as yet unavailable granular form of 2,4-D.

Hexazinone - Manufactured by DuPont.

Despite numerous gaps in its data base (particularly concerning potential environmental impact), and ambiguous toxicological results, EPA has closed the book on reviewing the herbicide, maintaining that its data base is adequate.

One of the top herbicides used in rights-of-way control and forestry, hexazinone is a broad-spectrum, systemic triazine herbicide which acts by disrupting plant photosynthesis.

According to EPA's 1982 Registration Standard and 1984

"Toxicology One-Liner," hexazinone is of moderate acute toxicity, with acute symptoms including eyed irritation and skin rashes. Minnesota forest workers complained of severe headaches upon exposure.

Negative for carcinogenicity in two studies in rats and mice, a third study, in mice, noted liver hypertrophy (abnormal increase in size), hyperplastic (unusual cell multiplication) nodules and focal necrosis (death of living tissue). Critics are concerned since at least one chemical cousin, atrazine, can cause cancer, and another, cyanazine, can cause birth defects. The Standard noted that pregnant female rabbits given high doses of hexazinone bore several pups with skeletal abnormalities (extra ribs) and delayed bone development. Mutagenicity results are inconclusive - a 1982 Chinese hamster study noted positive responses, although four other studies in different systems were negative.

EPA notes that the chemical and/or its metabolites have been found in goat (70 ppb) and cow (30-50 ppb) milk. The residue tolerance in meat, milk and eggs is 100 ppb.

A 1984 Alaska Railroad Environmental Assessment states that hexazinone residues and/or those of its principal metabolites are persistent in the soil anywhere from a few weeks to 12 months. The herbicide is highly water-soluble and leaches readily (a common problem among triazines).

Although EPA considers hexazinone to pose low acute risk to fish, independent scientists show the chemical's ability to concentrate in the bodies of terrestrial invertebrates. Much of the environmental fate data required by the 1982 Standard has since been waived.

- October 1986 Pesticides and You

Trichlopyr - Manufacturer: Dow Chemical (Garlon).

Widespread U.S. use for control of broad-leafed weeds in forest-site preparation and rights-of-way management programs.

Structurally, Garlon (registered in 1973) is a cousin of 2,4,5-T, and like T it mimics plant growth hormones called auxins, readily translocating throughout the plant. Unlike T, however, due to structural differences, trichlopyr does not contain dioxin.

It is slowly metabolized by soil microbes, having a soil half-life ranging from 79 days at 60 degrees F to 156 days at lower temperatures. The breakdown products, trichloropyridinol and trichloromethoxypyridine, are more persistent, with half-

lives ranging from 8-279 days and 50-300 days respectively. It binds poorly to the soil and is therefore expected to leach easily into ground and surface water. Of the two salt formulations available, triethylamine and the butoxyethlester (Garlon 3A and 4), the latter is much more toxic to fish.

Summaries of health and safety data reviewed by independent toxicologist Dr. Ruth Shearer, reveal that a statistically significant increase in benign lung tumors was found in a two year mouse feeding study at an eight-fold lower dose than normally is recommended in a carcinogenicity study.

- March 1986 Pesticides and You

NOTE: According to INM, Dow may not want its herbicide used for this purpose. INM has prepared an EA on the use of trichlopyr for its 1985 Colombia coca spray program, but no Pesticide Registration Standard for the product has been conducted to date by EPA.

Bibliography

Environmental Assessment of the Use of Herbicides to Eradicate Illicit Coca Crops Overseas, prepared for the U.S. State Department by Labat-Anderson, Inc., November 30, 1987.

Guidance for the Reregistration of Pesticide Products Containing Tebuthiuron as the Active Ingredient, Environmental Protection Agency, July 1987.

Hexazinone Pesticide Registration Standard, Environmental Protection Agency, February 1982.

Pesticides and You, newsletter of the National Coalition Against the Misuse of Pesticides, March and October 1986.

Greenpeace, June 1988
Sandra Marquardt

Comments on the Inconsistency Between
U.S. Law and the State
Department's Proposed Coca Eradication Project

July, 1988

There are a number of inconsistencies in the proposed coca eradication program that would make the program illegal were it to take place in the U.S.

1. The State Department holds that tebuthiuron is not registered for use in Peru. In order for a pesticide to be legally used in this country, it must be registered.

2. The proposed uses of tebuthiuron run contrary to use restrictions listed on the product label. In the U.S., these restrictions have the force of law. In looking at the label which is the last section of the Environmental Assessment, we note that:

a. Food uses: Use on food crops is illegal in U.S. no matter who is growing the food and as a result, there are no food residue tolerances established for direct applications (there are some for the pesticide in milk and meat since animals may graze on treated lands). Thus, even if it is a coca grower who is growing corn, a food crop is a food crop, and spraying his food would be illegal.

b. Erosion: The label says "Do not apply to areas where soil movement by water erosion and/or natural or mechanical means is likely." From all accounts, erosion is the likely result of application of Spike to hillsides.

c. Re-growth: As the label states, "Do not apply where future landscaping is planned." In our minds, landscaping includes reforestation or agricultural development, not grazing, which has its own deleterious environmental consequences.

d. Water contamination: The label states "Do not contaminate any body of water, ponds or streams as death or injury may occur to vegetation irrigated by such." With not only the tests sites, but also crop fields near major tributaries and other bodies of water, there is a strong chance water would become contaminated. Furthermore, erosion will carry tebuthiuron-contaminated soils into the river.

e. Endangered species: The Environmental Protection Agency currently requires that all tebuthiuron products carry an endangered species warning. According to State, Peru has no such listing. Indeed, the country has conducted no overall study to determine what types of plant and animal species are particular to the region.

APPENDIX IX.

PRELIMINARY DRAFT REPORT (not for reproduction or distribution): CONTROL OF COCA (*ERYTHROXYLUM* SPP.) WITH HERBICIDES IN PERU

Abstract. Dry formulations of tebuthiuron {N-[5-(1,1-dimethylethyl)-1,3,4- thiadiazol-2-yl]-N,N'-dimethylurea} as a 20 percent active ingredient (a.i.) extruded clay pellet and hexazinone # [3-cyclohexyl-6-(dimethylamino)-1-methyl- 1,3,5-triazine-2,4(1H,3H)- dione] as a percent sand core granule were applied at rates of 1.1 and 2.2 kg/ha by fixed-wing aircraft to designated coca fields in the Upper Huallaga Valley of Peru in mid-March 1989. Objectives of the experiments were to ascertain efficacy of the herbicides and to quantify residues of each herbicide in the soil on the treated area and determine if residues occurred in streams bordering the treated areas. Other fields in the vicinity were treated with hexazinone at 1.1 and 2.2 kg/ha and tebuthiuron at 1.1, 2.2, and 3.3 kg/ha for subsequent experiments to evaluate reseeding and recropping.

Soil and water samples were collected from a single field prior to being treated with the 2.2 kg/ha rate of either tebuthiuron or hexazinone. Test sites were revisited in April, May, June, and September 1989 to collect soil and water samples and observe target and nontarget vegetation within and near the designated plots. Tebuthiuron applied at either 1.1 or 2.2 kg/ ha was ineffective in controlling coca, but coca plants treated with 3.3 kg/ha of tebuthiuron displayed more than 90 percent defoliation and most of the plants were dead or dying in June 1989. Fields situated on level terrain and on hillsides treated with 3.3 kg/ha of tebuthiuron contained equivalent levels of coca mortality when observed in September 1989. Hexazinone at 1.1 kg/ha failed to reduce coca production, but the 2.2 kg/ha rate produced more than 60 percent defoliation within the treated field and more than half of the treated plants appeared dead by the 3 month posttreatment evaluation. Both herbicides dissipated in the soil during the first 3 months following treatment, with tebuthiuron being somewhat more persistant than hexazinone. Neither pesticide was detectable in fields treated at the 2.2 kg/ha rate after 6 months posttreatment. Neither herbicide was detectable in surface water at any date following treatment. Secondary plant succession was rapid and consisted mainly of grass species. Fields which received sufficient herbicide to defoliate or reduce the number of live plants by more than half were abandoned by growers.

INTRODUCTION

Of the 250 identified species comprising the genus Erythroxylum, two species contribute the majority of leaf material from which cocaine is produced. These two are *E. coca* Lam and *E. novogranatense* (Morris) and each has two varieties (Plowman 1979). The primary species of concern in Peru is *E. coca* var. *coca*, which was traditionally produced in greatest quantities near Cusco but is now grown primarily in the districts of Huanuco and San Martin in what was originally cloud forest and montane jungle. This area is generally referred to as the Upper Huallaga Valley, a name derived from the Huallaga River which, drains the broad mountain valley (Dourojeanni 1989).

Production of coca has contributed to environmental damage in the Amazonian region. Damage is evidenced in the form of destruction of the habitat of numerous species of plants and wildlife, increased erosion and nutrient loss due to slash-and-burn agricultural techniques, and potential soil, surface water, and groundwater contamination from indiscriminant use of pesticides by coca growers and improper disposal of chemicals (ether, kerosene, acetone) used for the processing of coca into basic paste. Although studies have yet to be conducted that quantify the extent and degree of damage to the environment directly attributable to coca production, photographic evidence of deforestation is dramatic.

The coca plant is a woody shrub, which with age can reach a height of more than 3 meters (m) (Plowman 1985). Under cultivation, the shrub is maintained at a height of 1 to 1.5 m to facilitate manual leaf harvest that may occur as frequently as 4 times per year. Shrubs are typically grown from seed in a nursery bed and transplanted to the field. Plants are typically planted in clusters of 3 with each cluster spaced on 0.8-m centers in rows which are 1-m apart. Rows are generally planted parallel with the slope on hillsides, presumably to facilitate leaf harvest and cultivation. Weed control is done by hand removal and cutting of competing herbaceous vegetation, which is subsequently placed between rows to serve as a mulch and possibly to enhance footing on the steep hillsides. Chemicals are also used to kill competing vegetation, with the herbicide paraquat (1,1'-dimethyl-4,4'-bipyridinium ion) being used most commonly. Insecticides of the carbamate group such as carbaryl (1-naphthyl-N-methylcarbamate) and organophosphates such as malathion [O,O-dimethyl-S-(1,2-dicarbethoxyethyl)

phosphorodithioate] are used to combat the leaf-consuming melonia moth (*Eloria noyesi*), foliarly applied fertilizer and micronutrients are used to encourage faster leaf development.

Little has been published regarding the physiology of the coca shrub growing *in situ*. Leaves appear to accumulate epicuticular wax with age and younger stems may be photosynthetically active. Root systems are typically lateral and superficial for plants less than 3 years old. Because coca has been used for centuries by native cultures, selectivity for enhanced leaf production has likely occurred. Carbohydrate storage is probably maintained in the above-ground stem tissue and net translocation to below-ground tissue and roots is assumed to be negligible in the Amazonian environment.

Herbicidal control using foliarly applied products was attempted on *E. coca* var. *ipadu* and *E. coca* var. *coca* in Colombia in 1984 and 1985 but produced disappointing results (Table 1). The *E. coca* var. *ipadu* appeared resistant to foliar uptake and demonstrated a strong ability to coppice. *E. coca var. coca* was more susceptible than the other to foliarly applied triclopyr {[(3,5,6-trichloro-2-pyridinyl)oxy]acetic acid} at a rate of 4.5 kg/ha. Droplet size distribution was unsatisfactory to achieve desired coverage with droplets in the 300 to 500 micron range due to the height of release above the target, which approached 30 m. Lateral displacement of the herbicide spray also produced noticeable effects on nontarget vegetation on the periphery of the target field. Additionally, coca cultivators were able to strip leaves from treated plants within 24 hours of the applications, effectively reducing herbicidal effects.

Based on the difficulties experienced with foliar applications, a small screening trial (Phase I) was conducted in Peru in August 1987 involving both foliar and ground applied herbicides (Table 2). Two additional trials (Phases II and III) confirmed the efficacy of soil-applied herbicides and identified two products, hexazinone [3-cyclohexyl-6-(dimethylamino)-1-methyl-1,3,5-triazine- 2,4(1H,3H)-dione] and tebuthiuron {N-[5-(1,1-dimethylethyl)-1,3,4- thiadiazol-2-y1]-N,N'-dimethylurea} as candidates for additional work. Herbicide residues in soils and water were determined at Phase I and Phase III. Tebuthiuron was more persistent than hexazinone in soil, no evidence of off-site movement of herbicide was found and no residues were found in water sources in the vicinity of the treated sites.

In April 1988 publicity regarding these field tests and the herbicides resulted in public controversy regarding the use of agrichemicals in the Andean environment. This controversy resulted in a decision by one manufacturer to cancel proposed sales of its product for coca control. Further Phase III tests in Peru were postponed as a result of these concerns.

In late October 1988 a group of scientists familiar with the use of tebuthiuron and hexazinone for shrub control in the United States met with representatives of the U.S. State Department and two key advisors for the Government of Peru to discuss use of those two products in the United States. Peruvian advisors also observed herbicide treated areas and aerial application techniques.

In mid-December 1988, Peruvian officials conducted an international conference in Lima to discuss the environmental impact of coca production. Representatives from all major environmental organizations in Peru participated in the conference and helped draft a 12-point resolution that included the recommendation to continue limited herbicide testing, with expansion to evaluate aerial application of herbicides.

Approval to proceed with the aerially applied herbicide test was received by the U.S. Embassy in Lima in mid-January 1989. In late January, Embassy representatives, consultants for the State Department, and officials of the Peruvian government as the U.S./Peruvian Herbicide Technical Team (HTT), participated in planning meetings and inspected proposed test sites in the Upper Huallaga Valley. Test protocols were developed by U.S. Department of Agriculture, Agricultural Research Service (USDA/ARS) scientists from the Tropical Plants Research Laboratory in Beltsville, MD. Test protocols included recommendations for test operational design, including application rates and site selection, and guidelines for soil and water sample collection for monitoring persistence and lateral movement of the herbicide (Appendix A).

MATERIALS AND METHODS

Description of the study area. The site selected for the herbicide test is located at latitude 08.39.49 S, longitude 76.22.77 W and is situated between the first two tributaries of the Rio Molopeyacu above its junction with the Rio Huamuco, a tributary of the Rio Huallaga. The site is approximately midpoint

between Tingo Maria and Tocache and is generally referenced as La Morada (Figure 1). Elevation is between 1,400 to 1,600 m and terrain is hilly. Original vegetational type was cloud forest and montane jungle, but this vegetation is being replaced with coca fields, most of which contain the remnants of downed trees, logs, and standing stumps which have been subjected to burning. Natural vegetation remains mainly along streams and rivers (Figure 2).

Only 4 fields were selected to be treated with each herbicide at the 1.1 and 2.2 kg/ha rates. This departure from the suggested 5 fields in the protocol (Appendix A) was necessitated by time constraints, security concerns and the requirement to locate fields with similar site characteristics within an accessible zone.

While formal experimental design would have been desirable for statistical anlyses of subsequent data, the nature of the terrain and size of fields did not permit the implimentations of such a design. Several additional fields outside the selected test area were treated with hexazinone at 1.1 and 2.2 kg/ha and tebuthiuron at 1.1, 2.2 and 3.3 kg/ha to permit future investigations regarding reseeding with native or introduced grasses and legumes and recropping studies.

Field descriptions were recorded prior to initiation of treatment and included location of nearby residences, type of nontarget vegetation present in or adjacent to the field, distance to the nearest surface water, observed animal life, and an estimate of the slope of the field (Table 3). Soils were preliminarily classified in the field as clay loams and clays and later confirmed in the laboratory (Table 4). Observations characterizing the coca crop were also recorded. Parameters included average height, diameter, and age of the plants, approximate leaf age, and the distance between plants and rows within the field (Table 5). Pretreatment soil and water samples were collected according to the sampling protocol (Table 6).

Method of aerial application. Upon completion of the pretreatment descriptions of the areas and collection of soil and water samples, two Turbo Thrush aircraft were summoned to the test site to apply the herbicides. One aircraft contained tebuthiuron pellets and the other carried hexazinone granules. Both aircraft were equipped with constant flow agitators mounted in the hopper throat to prevent bridging of the dry material and each was equipped with a Transland Slimline, Model 20240,

dry-material spreader. Each aircraft was calibrated at Tingo Maria by adjusting a sliding, slotted meter plate to a desired aperture that was predetermined from static and flight tests conducted in Athens, Georgia, during April 1988. The slotted plate was required to restrict the flow of material in order to apply the relatively low rates of herbicide. Both aircraft were calibrated to apply the lowest rate (1.1 kg/ha) and the higher rates were achieved by flying over the target fields two to achieve the 2.2 kg/ha rate or three times to achieve the 3.3 kg/ha rate. A restrictive slotted plate would not be required for rates above 2.2 kg/ha and, based on recently conducted deposition trials with pelleted materials, this should produce improved uniformity of application.

Herbicides were applied to the central portion of the field. Flight patterns for the tebuthiuron were from the top of the slope to the bottom. Hexazinone was applied in the same manner as the tebuthiuron on the fields receiving the 2.2 kg/ha rate and perpendicular to the slope for the 1.1 kg/ha rates. In all cases decisions on flight patterns were left to the descretion of the pilots as dictated by safe operating procedures. Applications of herbicides to the 16 fields designated to received the 1.1 and 2.2 kg/ha rates were observed and coordinated from a helicopter above the test area. Radio contact was maintained with both pilots during the operation. Upon completion of the tebuthiuron application in the designated test fields by the first aircraft, that aircraft was released to apply the residual herbicide to other fields at rates up to 3.3 kg/ha. After completion of the hexazinone application on the 8 fields selected for the 1.1 and 2.2 kg/ha rates, the pilot of that aircraft followed a similar procedure, but did not apply rates exceeding 2.2 kg/ha.

Rates of tebuthiuron deviated from those designated in the test protocol (Appendix A) in that a 4.5 kg/ha rate was not applied. This decision was predicated on the fact that rates utilized in previous screening trials had indicated that the 2 kg/ha was efficacious and this lower rate would be more desirable environmentally. Most woody plants in the U.S. which appear on the label for control with tebuthiuron can be controlled at rates less than 4.5 kg/ha (Appendix B). The sensitivities caused by earlier proposed use of tebuthiuron for coca control required that the lowest potentially efficacious rate be utilized in order to reduce anxieties of environmentalists and ecologists involved in the herbicide evaluation program.

Posttreatment evaluation techniques. Herbicide concentration in soils was analyzed at the USDA/ARS Tropical Plants Laboratory in Beltsville, Maryland. Twenty grams of moist soils was shake-extracted for one hour with 100 milliliters (ml) $MeOH_2$:OH. After filtering the extract, the residual soil was shake-extracted with 25 ml of the solvent for 10 minutes. Extracts were stored overnight at approximately 1°C, then concentrated by rotary evaporation. The final volume was adjusted to 4 ml by N_2. The extract was filtered (0.45 um), and analyzed by a Walter HPLC. A model 990 diode array detector was used for quantification.

Visual observations regarding herbicidal effects on coca plants in treated fields were recorded on preprinted forms. Parameters evaluated included leaf color, leaf desiccation, leaf malformation, plant leaf drop, and new leaf growth. Any obvious effects on nontarget vegetation were also noted, but not quantified.

RESULTS AND DISCUSSION

Control of coca was not achieved from either the 1.1 or 2.2 kg/ha rates of tebuthiuron, but high rates of control were observed in a field treated with the 3.3 kg/ha rate of tebuthiuron. Coca was not affected appreciably at the 1.1 kg/ha rate of hexazinone but control was achieved with the 2.2 kg/ha rate. Significant leaf reduction was achieved with hexazinone by the 1-month posttreatment evaluation, and plant mortality was observed on more than half of the coca shrubs by the 3-month posttreatment evaluation. Coca plants treated with the 2.2 kg/ha rate of tebuthiuron exhibited chlorosis at the 1-month posttreatment evaluation but the effects were no longer noticeable by the 3-month posttreatment evaluation.

Effects on coca in plots treated with tebuthiuron at the 3.3 kg/ha rate were not observed until the 3-month posttreatment evaluation. The pilot who conducted the applications to these fields accompanied the HTT to the fields to insure accurate identification of the treated areas. Estimates of defoliation ranged from 90 to 98 percent and most of the plants demonstrated desiccation in the terminal branches. The fields treated with this higher rate of tebuthiuron and the 2.2 kg/ha rate of hexazinone appeared to have been abandoned by the growers as evidenced by a general lack of maintenance and the appearance of secondary succession in progress by native vegetation.

Both herbicides demonstrated selectivity in that coca was controlled while other plant species show minor or no effects. Minor effects in the form of desiccation along leaf margins were noted on banana trees (*Musa paradisiaca* L.) in the hexazinone treatments. No visible effects were noted on papaya (*Carica papaya* L.), yuca (*Manihot esculenta* Crantz), or pineapple (*Ananas comosus* L.) at rates of tebuthiuron up to 3.3 kg/ha. Grasses were noticeably unaffected and included genera tentatively identified as: *Paspalum, Andropogon, Brachiaria, Axonopus, Digitaria, and Panicum.* Field collection of plants in the treated areas was accomplished during the 6-month posttreatment evaluation which will allow identification of the successional plants to genus and species. At present, there appears to be rapid secondary plant succession on treated and abandoned coca fields. Therefore, revegetation efforts do not appear feasible or necessary based on observations to date.

Herbicide residues in soil. Herbicide residue in soils from fields treated with 2.2 kg/ha of hexazinone and tebuthiuron was also evaluated at 1-, 2-, 3- and 6-month intervals according to protocol. At the 1-month sampling interval, hexazinone residue was found in all sample soil cores, while tebuthiuron residue was only detected in 20 percent of the cores (Table 7).

Two months following treatment, all sample cores from hexazinone-treated fields showed trace herbicide residue, but only in the upper 0 to 15 cm of soil (Table 8). Tebuthiuron residue was found in 50 percent of the cores and was evenly distributed throughout the 50 cm soil column (Table 9).

Three months following treatment trace residues were detected in only 20 percent of the cores from the hexazinone-treated fields and from 50 percent of the cores from the tebuthiuron-treated fields. Hexazinone residue was again found only in the upper 15 cm of the soil profile, while tebuthiuron residue was distributed throughout the sampled column (Tables 10 and 11).

Similar trends were observed in samples collected from the 3.3 kg/ha rate of tebuthiuron in June, July and September 1989. However, at 6 months following treatment, residual herbicide was still detected from 50 percent of the sample cores in the 3.3 kg/ha treatment area.

The data suggest that hexazinone dissipates to a non-detectable level after 2 months in the Peruvian environment and tends to degrade rather than leach from the soil profile. The projected soil half-life (the amount of time required for a 50 percent reduction in the amount of a chemical in the soil) for hexazinone in the Peruvian soils is 5 to 6 weeks. The average amount of hexazinone found in the upper 0.5 meter soil profile was 0.05 ± 0.02 kg/ha (or less) at the three-month sampling interval.

Tebuthiuron appears to be more persistent than hexazinone in the Peruvian environment, and appears to leach through the soil profile on the basis of laboratory analyses of samples. The predicted soil half-life for tebuthiuron was 24 ± 15 days based on the 2-month samples and 39 ± 38 days based on the 3 month samples. The half-life of tebuthiuron, however, cannot be accurately determined because of high variability in the data and limited sample size. The average amount of tebuthiuron found in the upper 0.5 meter soil profile was 0.25 ± 0.49 kg/ha at the three-month sampling interval.

Herbicide residues in water. No detectable levels of herbicide were found in water samples taken in the vicinity of the test fields.

Recommendations for future research and evaluation. Evaluations of herbicide efficacy should be continued and techniques should be modified to produce a more accurate and quantitative assessment of coca mortality. The forms presently being used provide an estimate of mortality based on estimation of new leaf development. This, however, is not as accurate as an actual plant count accompanied with an assessment of basal stem-kill by cutting and observing whether or not live, green tissue is present. In observations based on defoliation alone, a misleading assessment could be made owing to leaf removal by insects or man.

Additional research is needed to evaluate the influence ofsoil and site differences on herbicide effectiveness. Tebuthiuron can be bonded by clay particles and organic material (Duncan and Scifres 1983) and these factors may determine the most efficacious rate to be applied in Peru.

All future work should be closely coordinated with the Peruvian scientists and field operations should include allowances to collect the type of information that the Peruvian scientists deem necessary to obtain approval and support from authorities for herbicidal control use in the antidrug campaign.

ACKNOWLEDGEMENTS

Peruvian participation. Peruvian participation has been coordinated from the Ministry of the Interior and directed through a multisectorial commission composed of representatives from the Ministries of Health, Education, Agriculture, Industry, and Transportation. Additionally, representatives of various ecological and environmental groups have been given opportunities to participate in decisions and activities related to the herbicide test program that was recommended as part of a multipoint resolution at the International Conference on the Environmental Impact of Illegal Drug Trafficking held in Lima during December 1988.

The Herbicide Technical Team that has been directly active in field evaluations of the herbicide test program has consisted of scientists from the Ministry of Agriculture, the National Agricultural University at La Molina, the National Office for Evaluation of Natural Resources, and the Peruvian Federation for Preservation of Nature. These individuals have participated fully in the collection of field data, soil, and water samples.

LITERATURE CITED

Dourojeanni, M.J. 1988. The environmental impact of coca cultivation and cocaine production in the Peruvian Amazon. Unpublished document AIO:242P:6/9/88.

Duncan, K.W. and C.J. Scifres. 1983. Influence of clay and organic matter contents of rangeland soils on tebuthiuron effectiveness. J. Range Manage. 36:295-297.

Plowman, T. 1979. Botanical perspectives on coca. J. Psychedelic Drugs 11:103-117.

Plowman, T. 1984. The ethnobotany of coca (Erythroxylum spp., Erythroxylacea). Advances in Economic Botany 1:62-111.

Plowman, T. 1985. Coca chewing and the botanical origins of coca (Erythroxylum spp.) in South America. 31 p. In: D. Pacini and C. Franquemont (eds.). Coca and Cocaine - Effects on people and policy in Latin America. Latin American Studies Program, Cornell University.

LIST OF TABLES, FIGURES AND APPENDICES

Table 1. Previous Herbicide Trials on Coca.

Table 2. Summary of Herbicide Trials (Phase I, II, and III) in the Upper Huallaga Valley of Peru during 1987-1988 to Evaluate Efficacy of Products and Rates.

Table 3. Pretest Field Description.

Table 4. Characterization of Soil from the Phase IV Coca Eradication Test Site in Peru.

Table 5. Pretest Crop Characterization.

Table 6. Hexazinone and Tebuthiuron Residues in Soil: Pretreatment Samples.

Table 7. Hexazinone and Tebuthiuron Residues in Soil: One Month Samples.

Table 8. Hexazinone Residue in Soil from Field H2-A after 2 Months.

Table 9. Tebuthiuron Residue in Soil from Field T2-A after 2 Months.

Table 10. Hexazinone Residue in Soil from Field H2-A after 3 Months.

Table 11. Tebuthiuron Residue in Soil from Field T2-A after 3 Months.

Appendix A. Test Protocol.

Appendix B. Spike® Label.

Figure 1. Map Showing General Location of the Test Area.

TABLE 1. PREVIOUS HERBICIDE TRIALS ON COCA

Herbicide	Formulation	Application rate	Site/Date	% Mortality
trichlopyr	Garlon 4	•	Colombia/1985	75
picloram	Tordon (20% conc.)	•	Colombia/1985	100
picloram	Tordon (20% conc.)	1/2 above rate	Colombia/1985	15
picloram	Tordon (20% conc.)	8 ml/plant	Peru/1987	14
trichlopyr + picloram	Garlon 4 + Tordon	•	Colombia/1985	100
trichlopyr + picloram	Garlon 4 + Tordon	1/2 above rate	Colombia/1985	40
hexazinone	Velpar (20% conc.)	•	Colombia/1985	50
hexazinone	Velpar (20% conc.)	4 ml/plant	Peru/1987	60
hexazinone	Velpar (20% conc.)	8 ml/plant	Peru/1987	60
glyphosate	Round-up (41% conc.)	•	Colombia/1985	40
glyphosate	Round-up (41% conc.)	•	Peru/1987	0
2,4-D	•	•	Colombia/1985	0
dicamba	Banvel (48% conc.)	•	Colombia/1985	0
dicamba	Banvel (48% conc.)	8 ml/plant	Peru/1987	13
cacodylic acid	Phytar 560 (33% conc.)	13.4 kg/ha	Peru/1987	4
tebuthiuron	Spike (20% pellet)	4 kg/ha	Peru/1987	40
tebuthiuron	Spike (20% pellet)	8 kg/ha	Peru/1987	36
tebuthiuron	Spike (40% pellet)	8 kg/ha	Peru/1987	23
tebuthiuron	Spike (40% pellet)	16 kg/ha	Peru/1987	29

• Information not recorded

TABLE 2. SUMMARY OF HERBICIDE TRIALS (PHASES I, II,III) APPLIED IN THE UPPER HUELLAGA VALLEY OF PERU DURING 1987-1988 TO EVALUATE EFFICACY OF PRODUCTS AND RATES

Phase	Date	Objective	Application Methods	Herbicide	Rate	Mortality (%)
I	10/89	Screening	Basal/Soil	Dicamba	8 ml/plant	13
				Picloram	8 ml/plant	14
			Foliar Spray	Glyphosate	200 ml/6 L	0
				Cacodylic Acid	13.4 kg/ha	4
			Basal/Soil	Hexazinone (80% L)	4 ml/plant	100
				Hexazinone (80 % L)	8 ml/plant	100
				Tebuthiuron (20 % P)	4 kg/ha	100
				Tebuthiuron (20 % P)	8 kg/ha	100
				Tebuthiuron (40 % P)	8 kg/ha	23
				Tebuthiuron (40 % P)	16 kg/ha	29
II	12/87	Screening	Broadcast	Picloram (10 % P)	4 kg/ha	40
				Tebuthiuron (20 % P)	2,4 kg/ha	100
				Tebuthiuron (40 % P)	8 kg/ha	100
			Basal/Soil	Hexazinone (80 % L)	1,2,4 ml/ plant	50-100
				Hexazinone (10 % gridball)	1,2 kg/ha	20
III	3/88	Lateral Runoff	Broadcast	Hexazinone (10 % gridball)	12 kg/ha	0
				Tebuthiuron (20 % P)	12 kg/ha	100

TABLE 3. PRETEST FIELD DESCRIPTION

Field	Residences (distance from field)	Adjacent Nontarget Vegetation	Streams (distance from field)	Animals	Slope (%)
H1-A	Two huts (20 & 50 m)	Papaya, banana, yucca, forest	One (75 m)	Horses, dogs	25
H1-B	One hut (75 m)	Broadleaf, banana, cocoa heavy jungle	One (25 m)	None observed	30
H1-C	One hut (< 10 m)	Cocoa, banana, papaya, achiote, anona, orange trees, yuca	One (5 m)	None observed	3 & 35
H1-D	Two huts (< 5 m)	Yuca, papaya, forest	One (< 10 m)	None observed	3-5 & 60
H2-A	Three huts (< 50 m)	Forest	One (150 m)	None observed	35
H2-B	None	Yuca	None	Horses, pigs, chickens	10 & 15
H2-C	None	Sparse trees	None	Horses	10 & 15
H2-D	One hut (< 20 m)	Banana, yuca, forest	One (50 m)	None observed	30
T1-A	One hut (150 m)	Banana, papaya, yuca pineapple, sparse forest	One (20 m)	Tucan	15 & 40
T1-B	None	Forest	One (10 m)	None observed	15 & 35
T1-C	Two huts (250 & 60 m)	Yuca, ferns, grasses	One (10 m)	None observed	25 & 30
T1-D	Four huts (< 10 m)	Yuca, papaya, ferns, banana, cocoa, forest	One (< 20 m)	None observed	45-50 & 3
T2-A	One hut (150 m)	Sparse and heavy forest	One (100 m)	None observed	30 & 50
T2-B	One house (unspecified)	Forest	One (50 m)	None observed	Not Recorded
T2-C	Not Recorded	Mature trees, grasses, ferns	Not Recorded	None observed	50
T2-D	One hut (< 100 m)	Mature trees	Two (No distance recorded)	None observed	3 & 35

TABLE 4. CHARACTERIZATION OF SOIL FROM THE PHASE IV COCA CONTROL TEST SITE, PERU

Field[1]	Sample site[2]	Soil depth cm	Soil texture	Textural composition, % sand	silt	clay	Organic matter %	pH 1:1	CEC 1:1 me/100 g	Macronutrients, lb/acre[3,4] Mg	P_2O_5	K_2O	NO_3	Ca	B	Micronutrients, lb/acre Cu	Mn	SO_4	Zn
H2-A	1/2/3	0-15	clay loam	40	26	34	3.3	4.1	5.7	2 VL	24 VL	59 L	46.6	98	0.40	14.7	12	6.8	2.5
		15-30	clay loam	34	26	40	2.0	4.4	4.5	3 VL	15 VL	31 VL	31.3	68	0.40	2.4	5	3.4	1.6
H2-A	4/5/6	0-15	clay loam	37	26	37	2.4	4.4	5.8	10VL	14 VL	62 L	16.5	98	0.35	5.5	12	2.4	1.0
		15-30	clay	36	21	43	1.7	4.6	4.7	4 VL	11 VL	40 L	19.4	107	0.26	3.1	43	5.8	0.9
H2-A	7/8/9	0-15	clay loam	42	24	34	3.5	4.4	5.2	33 VL	20 VL	99 M	68.5	166	0.42	14.2	57	5.6	1.7
		15-30	clay	33	20	47	1.8	4.7	4.5	7 VL	10 VL	34 VL	19.9	92	0.30	2.7	8	14.7	1.2
T2-A	1/2/3	0-15	clay loam	41	24	35	3.3	4.3	6.9	103 M	16 VL	157 M	43.1	325	0.46	9.7	44	6.8	2.4
		15-30	clay loam	37	23	40	3.1	5.0	5.9	172 M	21 VL	133 M	28.4	475	0.65	6.8	39	44.5	1.9
T2-A	4/5/6	0-15	clay loam	40	23	37	3.4	4.6	5.8	34 VL	14 VL	179 H	51.6	118	0.67	4.7	62	38.1	1.5
		15-30	clay	37	22	41	2.1	4.9	5.9	60 L	10 VL	122 M	31.3	136	0.64	5.0	45	4.9	1.4
T2-A	7/8/9	0-15	loam	38	39	23	5.1	5.4	9.2	300+VH	28 VL	270 H	73.4	1600	0.68	4.4	50	1.6	3.7
		15-30	loam	36	41	23	1.4	5.0	5.3	134 H	7 VL	171 H	32.8	239	0.34	0.3	41	13.6	37.2

[1]Field H2-A was treated with 2lb/acre hexazinone; Field T2OA was treated with 2lb/acre tebuthiuron. Soil collection was made prior to treatment.

[2]Sampling site is a composite of three coring location (e.g., 1 + 2 + 3), all on approximately the same elevation.

[3]Fertility levels, as defined by the Maryland Soil Testing Lab and with reference to major Maryland field crops: VL = very low; L = low; M = medium; H = high; and VH = very high.

[4]Results were reported by testing lab as "lb/acre". They assume 2 X 10^6 lbs/acre (6" depth), so multiply these values by 0.5 to convert to ppm basis.

[5]To convert to elemental basis, multiply by 0.218 (P_2O_5 to P) or 0.415 (K_2O to K).

TABLE 5. PRETEST CROP CHARACTERIZATION

Field	Average Plant Characteristics			Distance Between		
	Height (cm)	Diameter (cm)	Age (years)	Plants (cm)	Rows (cm)	Leaf Age
H1-A	70	50	< 2	80	150	3 months
H1-B	180	125	> 3	100	150	3 months
H1-C*	130	60	> 3	30-80	100	3 months
HI-D	100	70	2	80	100	3 months
H2-A	140	17	3	NR	100	2 weeks
H2-B	150	NR	2-3	80	100	2 months
H2-C	150	60-80	2-3	70	100	1 month
H2-D	150	60-70	2-3	80	100	3-4 months
T1-A	100	70-80	2	50	100	3 months
T1-B	120	60-80	2	50	100	3 months
T1-C	120	80	2	20-50	120	3 months
T1-D*	120	NR	> 3	50	100	3 months
T2-A	140	50-60	1-2	80	110	2.5 months
T2-B	Young plants – non-harvest mixture of emergence stages					
T2-C	50-60	50-60	< 1	NR	100	NR
T2-D	120	80-100	2-3	NR	100	2.5 months

* Plants grown in clusters of three
NR Indicates not recorded

TABLE 6. HEXAZINONE AND TEBUTHIURON RESIDUES IN SOIL: PRETREATMENT SAMPLES

Sample date	Treatment & rate	Increment depth (cm)	Sample code	Herbicide conc., ppb	
				Hexazinone	Tebuthiuron
3/15/89	Hex-2	0-15	H2A-1(0-15)	0	0
"	"	15-30	H2A-1(15-30)	0	0
"	"	0-15	H2A-2(0-15)	0	0
"	"	"	"	8	0
"	"	"	"	4	0
"	Teb-2	15-30	T2A-1(15-30)	0	0
"	"	"	"	0	0
"	"	"	T2A-2(15-30)	0	0
			T2A-3(15-30)	0	0

TABLE 7. HEXAZINONE AND TEBUTHIURON RESIDUES IN SOIL: ONE MONTH SAMPLES

Sample date	Core	Increment depth (cm)	Sample code	Herbicide conc., ppb Hexazinone	Tebuthiuron
Hexazinone 2.2 kg/ha					
4/13/89	Hex-1	0-15	H2-19	27	0
"	"	15-30	H2-20	0	0
"	"	30-50	H2-21	13	0
"	Hex-2	0-15	H2-22	71 (74)*	0 (0)*
"	"	15-30	H2-23	143 (tr)*	0 (0)*
"	"	30-50	H2-24	6 (0)*	0 (0)*
"	Hex-3	0-15	H2-25	9	0
"	"	15-30	H2-26	25	0
"	"	30-50	H2-27	26	0
"	Hex-4	0-15	H2-28	240	12
"	"	15-30	H2-29	122	0
"	"	30-50	H2-30	97	0
"	Hex-5	0-15	H2-31	34	0
"	"	15-30	H2-32	5	0
"	"	30-50	H2-33	0	0
Tebuthiuron 2.2kg/ha					
4/13/89	Teb-1	0-15	T2-19	0	0
"	"	15-30	T2-20	0	0
"	"	30-50	T2-21	13	0
"	2	0-15	T2-22	0	512
"	"	15-30	T2-23	0	86
"	"	30-50	T2-24	0	16
"	3	0-15	T2-25	6	15
"	"	15-30	T2-26	0	13
"	"	30-50	T2-27	0	9

TABLE 7 (cont). HEXAZINONE AND TEBUTHIURON RESIDUES IN SOIL: ONE MONTH SAMPLES

Sample date	Core	Increment depth (cm)	Sample code	Herbicide conc., ppb Hexazinone	Tebuthiuron
Tebuthiuron 2.2 kg/ha					
"	4	0-15	T2-28	0 (0)*	9 (9)*
"	"	15-30	T2-29	0 (0)*	15 (0)*
"	"	30-50	T2-30	0 (0)*	19 (0)*
"	5	0-15	T2-31	0	0
"	"	15-30	T2-32	0	0
"	"	30-50	T2-33	0	0

* Values in parentheses indicate concentrations determined by the USDA/ARS Beltsville Laboratory

TABLE 8. HEXAZINONE RESIDUE IN SOIL FROM FIELD H2-A AFTER 2 MONTHS

Sample code	Core	Soil depth (cm)	Soil moisture content (%)	Hexazinone found (ppm)	Estimated hexazinone recovery (lb/acre)
H2-34	6	0-15	54.5	0.059	0.10
H2-35	"	15-30	52.0	ND	<0.03
H2-36	"	30-50	41.4	0.024	0.06
Total					0.18
H2-37	7	0-15	51.9	0.068	0.12
H2-38	"	15-30	51.9	0.030	0.05
H2-39	"	30-50	53.1	0.036	0.08
Total					0.25
H2-40	8	0-15	50.6	0.070	0.12
H2-41	"	15-30	42.7	ND	<0.03
H2-42	"	30-50	42.1	ND	<0.04
Total					0.16
H2-43	9	0-15	49.5	0.021	0.04
H2-44	"	15-30	43.8	ND	<0.03
H2-45	"	30-50	42.0	ND	<0.04
Total					<0.05
H2-46	10	0-15	42.8	0.042	0.07
H2-47	"	15-30	44.5	ND	<0.03
H2-48	"	30-50	45.3	0.020	0.05
Total					0.13

ND or Not detectable is below the limit of detection (0.020 ppm)

TABLE 9. TEBUTHIURON RESIDUE IN SOIL FROM FIELD T2-A AFTER 2 MONTHS

Sample code	Core	Soil depth (cm)	Soil moisture content (%)	Tebuthiuron found (ppm)	Estimated tebuthiuron recovery (lb/acre)
T2-34	6	0-15	63.6	ND	< 0.03
T2-35	"	15-30	41.5	ND	0.00
T2-36	"	30-50	38.6	ND	0.00
Total					< 0.03
T2-37	7	0-15	53.8	ND	< 0.03
T2-38	"	15-30	49.7	ND	< 0.03
T2-39	"	30-50	50.9	ND	< 0.04
Total					< 0.04
T2-40	8	0-15	53.5	0.109	0.19
T2-41	"	15-30	51.5	0.046	0.08
T2-42	"	30-50	46.2	0.046	0.11
Total				0.38	
T2-43	9	0-15	58.7	ND	< 0.03
T2-44	"	15-30	56.6	ND	< 0.03
T2-45	"	30-50	52.1	0.021	0.05
Total					0.08
T2-46	10	0-15	50.3	0.153	0.27
T2-47	"	15-30	48.2	0.130	0.23
T2-48	"	30-50	49.2	0.112	0.26
Total					0.75
T2-49	11	0-15	71.2	ND	0.00
T2-50	"	15-30	51.4	ND	0.00
T2-51	"	30-50	40.6	ND	0.00
Total					0.00

ND or not detectable is below the limit of detection (0.020 ppm)

TABLE 10. HEXAZINONE RESIDUE IN SOIL FROM FIELD H2-A AFTER 3 MONTHS

Sample code	Core	Soil depth (cm)	Soil moisture content (%)	Hexazinone found (ppm)	Estimated hexazinone recovery (lb/acre)
H2-49	11	0-15	49.9	ND	<0.03
H2-50	"	15-30	43.2	ND	0.00
H2-51	"	30-5)	43.4	ND	0.00
Total					<0.03
H2-52	12	0-15	50.0	0.031	0.05
H2-53	"	15-30	44.3	ND	<0.03
H2-54	"	30-50	39.8	ND	<0.04
Total					0.07
H2-55	13	0-15	57.4	0.030	0.05
H2-56	"	15-30	49.6	ND	<0.03
H2-57	"	30-50	46.7	ND	<0.04
Total					0.07
H2-58	14	0-15	52.0	ND	<0.03
H2-59	"	15-30	46.8	ND	0.00
H2-60	"	30-50	48.3	ND	<0.04
Total					0.04
H2-61	15	0-15	50.9	ND	<0.03
H2-62	"	15-30	46.7	ND	<0.03
H2-63	"	30-50	49.1	ND	0.00
Total					<0.03

ND or Not detectable is below the limit of detection (0.020 ppm)

TABLE 11. TEBUTHIURON RESIDUE IN SOIL FROM FIELD T2-A AFTER 3 MONTHS

Sample code	Core	Soil depth (cm)	Soil moisture content (%)	Tebuthiuron found (ppm)	Estimated tebuthiuron recovery (lb/acre)
T2-52	11	0-15	73.2	ND	< 0.03
T2-53	"	15-30	49.0	0.037	0.06
T2-54	"	30-50	39.9	ND	0.00
Total					0.07
T2-55	12	0-15	62.6	ND	0.00
T2-56	"	15-30	54.5	ND	< 0.03
T2-57	"	30-50	51.6	ND	0.04
Total					< 0.04
T2-58	13	0-15	58.0	0.218	0.38
T2-59	"	15-30	54.2	0.008	0.40
T2-60	"	30-50	50.5	0.198	0.46
Total					1.24
T2-61	14	0-15	63.6	ND	< 0.03
T2-62	"	15-30	57.5	ND	< 0.03
T2-63	"	30-50	57.2	ND	< 0.04
Total					< 0.05
T2-64	15	0-15	62.7	0.023	0.04
T2-65	"	15-30	61.1	ND	< 0.03
T2-66	"	30-50	35.0	ND	< 0.04
Total					0.05
T2-67	16	0-15	60.4	ND	0.00
T2-68	"	15-30	44.3	ND	0.00
T2-69	"	30-50	43.0	ND	< 0.04
Total					< 0.04

ND or Not detectable is below the limit of detection (0.020 ppm)

APPENDIX A. Protocol for Herbicide Efficacy Trial in Peru

HERBICIDE EFFICACY TRIAL

OBJECTIVE

The objective of this program is to establish the optimum parameters for an operational strategy to control cocaine-bearing plants ("coca") in producing countries. These parameters include herbicide selection, rate, method, and time of application. In addition, collection of environmental monitoring data are also included in the scope of this trial.

OPERATIONAL DESIGN

While a standard statistical design such as a complete factorial would be desirable, field conditions and security in the country will prevent the implementation of such a design; that is, it would be impossible to locate a field large enough with uniform plant populations. Each treatment will be applied in areas (or zones) of approximately 5 hectares each. Each treated area will have its own untreated areas on the edges, ends, and so forth; therefore, for the treatments proposed in Table 2, the minimum requirement is 30 hectares.

PLOT SELECTION

Plot areas must be readily available for aerial application. Each treatment area should be approximately 5 hectares. Data to be collected on each area of treatment are presented in Table 1.

HERBICIDES

Table 2 presents the herbicides selected for use in the trial in order of priority. The herbicides of choice are tebuthiuron and hexazinone.

Formulations

In general, products should always be prepared following label instructions. Table 3 presents the formulations for the two herbicides recommended for the pilot program.

Applications

Aerial applications should be used throughout the program. Data that should be recorded at application include meter setting and approximate pounds per minute of herbicide applied.

DATA COLLECTION

Efficacy

Plots should be scored separately for phytotoxicity, defoliation, and speed and amount of new growth using a 0 to 10 system (with 1 = no effect, and 10 = death or complete defoliation). Data should be collected at 3, 6, and 12 weeks; 6 months; and 1 year after application. Efficacy will be taken on all rates for each herbicide.

Environmental

To monitor persistance and lateral movement of the herbicide, soil samples should be collected at 1 day pre-treatment; post-treatment (on the day of treatment), 3, 6, and 12 weeks; 6 months; and 1 year after application. Soil samples will be collected at 1 day pre-treatment, post-treatment (on the day of application), 3, 6, and 12 weeks; 6 months; and 1 year after application. Soil samples will be collected from treatment sites of each herbicide with the highest application rates (4 lbs/A). All soil samples will be analyzed for herbicide residues to estimate persistence, as well as vertical and lateral movement. If feasible, soil samples may be collected from additional sites treated at a lower application rate (2 lbs/A).

Water samples should be collected at pretreatment; posttreatment (on the day of application); 3, 6, and 12 weeks; 6 months; and 1 year after application. Water samples will be collected from streams adjacent to treatment sites with the highest application rate of each herbicide. Samples will be analyzed for herbicide residues to estimate the potential for herbicide leaching and runoff.

Revegetation Analysis

Secondary succession of native plants in treated areas will be evaluated by a plant ecologist at 12 weeks, 6 months, and 1 year.

Table 1
Data Collection for Each Treatment Area

Treatment number (sequential identification number and color code)
Treatment locations (provided on map of the area)
Plot orientation (row direction on slope)
Plant species, variety
Plant height and age
Leaf size (collect samples, if feasible)
Description of terrain (degree of slope, proximity to water, and proximity of adjacent housing or livestock)
Contiguous vegetation
Elevation above sea level
Soil moisture (at depth of 3 to 6 inches)
Temperature (air)
Relative humidity (air)
Wind speed and direction
Time of day

NOTE: To the extent feasible, rainfall data (dates and amounts) for one week prior to application and 12 months following application should be obtained from the monitoring station nearest to the areas of treatment.

Table 2
Selected Herbicides

Common Name	Trade Name	Treatment	Active Ingredient lb/acre	Active Ingredient Kg/ha
Tebuthiuron	Spike 20P	1	1	1.12
(pellets)	(20% a.e.*)	2	2	2.2
		3	4	4.5
Hexazinone	Velpar	4	1	1.12
(granular)	(10% a.e.*)	5	2	2.2
		6	4	4.5
Untreated	–	7	–	–

*Acid equivalent.

Table 3
Application Rates

Acid Equivalent lb/A Teb and Hex	Acid Equivalent Kg/ha Teb and Hex	Rate of Product lb/A Teb 20%	Rate of Product lb/A Hex 10%	Rate of Product Kg/ha Teb 20%	Rate of Product Kg/ha Hex 10%
1	1.12	5	10	5.6	11.2
2	2.2	10	20	11.2	22.4
4	4.5	20	40	22.4	44.8

APPENDIX B. Label for Tebuthiuron Usage on Pastureland, Rangeland and Non-Cropland in the United States

SPECIMEN LABEL

ELANCO ID 5954

Herbicide

Spike

20P

TM

Net Weight 25 Pounds

A Surface Applied Herbicide For Control of Brush and Woody Plants in areas such as:

- Along highways
- Ditchbanks
- Fence rows
- Firebreaks
- Industrial sites
- Pastures
- Pipelines
- Railroad rights-of-way
- Rangeland
- Utility rights-of-way
- Other noncropland areas for the control of woody plant species
- Wildlife openings

Spike will kill trees and shrubs. Carefully read the precautions before using.

The degree and duration of control may vary with the amount of chemical applied, soil texture and other conditions.

Active Ingredient:	
tebuthiuron*: *N*-[5-(1,1-dimethylethyl)-1,3,4-thiadiazol-2-yl]-*N*,*N*'-dimethylurea . .	20.0%
Inert Ingredients.	80.0%

Contains 5 pounds active ingredient per 25 pound bag.
*Spike® — (tebuthiuron, Elanco)

Keep Out of Reach of Children.

CAUTION

Not For Residential Use

FH 1150
EPA Reg. No. 1471-123
EPA Est. 39575-TX-1

Precautionary Statements

CAUTION

Hazards to Humans and Domestic Animals

Causes eye irritation. Harmful if swallowed, inhaled, or absorbed through the skin. Avoid breathing dust and contact with skin, eyes, or clothing. Use eye protection and protective clothing, such as coveralls, a long-sleeved shirt, and impermeable gloves when handling this product. Wash thoroughly with soap and water after handling. Remove contaminated clothing and wash before reuse.

Statements of Practical Treatment

If swallowed: Call a physician or Poison Control Center. Drink one or two glasses of water and induce vomiting by touching back of throat with finger or, if available, by administering one to two teaspoons of syrup of ipecac. Do not induce vomiting or give anything by mouth to an unconscious person.

If on skin: Wash with plenty of soap and water. Get medical attention if irritation develops.

If in eyes: Flush eyes with plenty of water. Call a physician if irritation develops.

If inhaled: Remove individual to fresh air. If breathing difficulty occurs, get medical attention. If not breathing, provide cardiopulmonary resuscitation assistance (mouth-to-mouth) and get medical attention.

Environmental Hazards

Precaution: Do not use Spike 20P in any area where desirable species are in the vicinity of the plants to be controlled. A small amount of Spike in contact with the roots of desirable trees or other woody species may cause severe injury or death. The roots of such plants may extend far beyond their drip lines.

Collect pellets spilled on the soil surface. Do not apply directly to water or wetlands (swamps, bogs, marshes and potholes). Do not contaminate water by cleaning of equipment or when disposing of wastes or equipment washwaters.

Do not apply to any portion of the ditchbank that will come into contact with water. Do not apply on ditches used to transport irrigation or potable water.

Storage and Disposal

Storage: The herbicidal properties of Spike 20P require caution in handling, storage and transportation of this product. Store in original container only. In case of leak or spill, contain material and dispose as waste.

Pesticide Disposal: Do not contaminate water, food, or feed by storage or disposal. Open dumping is prohibited. Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.

Container Disposal: Completely empty container — do not reuse. Then dispose of empty container in a sanitary landfill, or by incineration, or, if allowed by State and local authorities, by burning. If burned, stay out of smoke.

Precautions

Spike 20P is intended for brush and woody plant vegetation control. It is an extremely active herbicide which will kill trees, shrubs and other forms of desirable vegetation having roots extending into the treated area. Feeder roots of many species of desirable vegetation extend many feet beyond the drip line of the branches and a very small amount of Spike in contact with one feeder root of a tree, shrub or other desirable vegetation may cause serious injury or death to the entire plant. Spike 20P may seriously injure desirable forage legumes such as lespedeza or clover.

An arboriculturist (tree expert) should be consulted to help you to determine if the area of proposed application is free of all roots of desirable vegetation. The effect of Spike 20P on desirable vegetation may be irreversible and its presence in the soil may prevent growth of other desirable vegetation for some years after application.

Read the entire label before using Spike 20P to determine if this product is suitable for the desired purpose.

Do not use Spike 20P on areas such as walks, driveways, streets, lawns, patios, tennis courts, swimming pools, cemeteries, or other landscaped areas, or under asphalt or concrete pavement where future landscaping is planned. Do not apply on field crops. Do not apply on any area into which the roots of field crops or other desirable vegetation may extend. Roots of trees, shrubs and other desirable vegetation may extend far beyond the drip line of the plant's branches.

Avoid nontarget drift or product movement. Do not apply when winds are gusty or under any other condition which will cause drift or product movement. Do not apply to areas where soil movement from treated area by water erosion and/or natural or mechanical means from the target area is likely. Do not apply to areas where wind is likely to cause soil movement from the treated area unless a soil sealant is used. Drift or any form of product movement from treated areas may cause unintentional damage to vegetation outside the treated area.

Ditchbank Usage: Do not apply Spike 20P to any portion of the ditchbank that will come into direct contact with water as movement of Spike 20P in this water to nontarget plant species may result in the injury or death of those plants. Do not apply on ditches used to transport irrigation or potable water. Keep from contact with other pesticides and seeds.

Thoroughly clean all traces of Spike 20P from application equipment after use. Do not empty residues cleaned from application equipment on areas where they may come in contact with the roots of desirable vegetation or the water source for such vegetation.

Grazing and Haying: Grazing is only allowed in areas treated with 20 pounds per acre or less of Spike 20P. In areas treated with 20 pounds per acre or less of Spike 20P, grass may be cut for hay one year after application.

Spike 20P may injure or suppress certain herbaceous vegetation in the treated area. Therefore, do not apply where such injury cannot be tolerated. Injury to most herbaceous perennials is reduced if Spike 20P is applied when this vegetation is dormant.

Directions for Use

Read All Directions Carefully Before Applying

It is a violation of Federal Law to use this product in a manner inconsistent with its labeling.

General Use Information Mode of Action

Spike 20P is a root-active soil applied herbicide for control of woody plants (trees, shrubs and brush). Treatments become effective after sufficient rainfall has occurred to move Spike's active ingredient into the root zone. Herbicidal symptoms appear most rapidly when applied just prior to seasonal rainfall. Treated trees and brush may go through several defoliation cycles before death occurs. Time required to achieve control of trees and brush plants may vary from one to three years and is dependent on rainfall, soil texture, soil/rooting depth and susceptibility of target species.

For best results, do not disturb trees or brush by wood cutting, chaining or burning for two years after Spike 20P application.

Application Precautions

Spike 20P may be applied anytime except when the ground is frozen or the soil is saturated with moisture. For optimum results, applications should be made prior to the resumption of active seasonal growth in the spring or before expected seasonal rainfall. In areas receiving greater than 25 inches of annual rainfall, late summer and fall applications may require a higher application rate in the rate range to achieve consistent control. Increased application rates should also be used to avoid inconsistent control in cases of hard-to-control species, deep fine-textured or high organic matter soils and dense brush infestations.

Spike 20P may be used to control cut brush regrowth provided the regrowth has reached an approximate minimum height of 5 feet prior to application. Spike requires an abundance of active new growth to stimulate the water and herbicide uptake necessary to produce optimum results. Taller regrowth will tend to provide faster and more consistent control.

Soil Precautions

Poor control or erratic results are likely to occur when Spike 20P is applied to soils containing more than 5% organic matter or more than 30% clay. Do not apply to "blackland" or other heavy clay soils which crack extensively upon drying. Other deep, medium and fine-textured soils supporting deep-rooted woody plant species require increased application rates for consistent control.

Pasture and Rangeland Management Information

Spike 20P may cause temporary herbicidal symptoms to appear on perennial grasses. Dormant season application is recommended to minimize herbicidal effects on desirable forage grasses. For optimal forage grass response, desirable perennial species should be present at a minimum of 10% of normal plant density (density = plants per unit area) compared to similar rangeland sites not dominated by woody plants. To encourage forage grass response, grazing should be deferred during the entire active growing season following application. Light grazing of dry forage after seed maturity will not harm grass recovery and will aid seed dispersal. Forage grass production usually increases as brush competition is reduced. However, increased grass production is also dependant on adequate rainfall and a sound grazing management program.

The density of cool season grass stands such as fescue and crested wheatgrass may be reduced by Spike 20P application. Factors which may contribute to the possibility of stand reduction include excessive application rates, shallow or rocky soils and low brush density.

Rangeland/Pasture Overseeding

Apply Spike 20P at recommended rates. Overseeding involving burning or chaining of treated brush should not be attempted for at least two growing seasons after application. Apply seed and fertilizer at recommended rates into ash as soon as possible after burning or just prior to chaining. Cool season grass species are normally seeded in early fall and warm season species in spring after date of last frost. Aerial seeding without burning or chaining may be attempted in the fall or spring following application, but natural seed bed conditions must be relied upon for seedling establishment. Consult local range management or pasture specialists for recommendations on overseeding mixtures, optimal seeding time and grazing management.

Spot Treatment and Hand Broadcast Applications

Use a spot treatment method to control individual trees or shrubs and a hand broadcast treatment method to control multi-stemmed clumps or stands of trees and brush. For individual plant treatment, apply Spike 20P evenly around the base of the stem at a rate of 1/4 oz per 1 to 2 inches of stem diameter. For larger clumps or stands with multiple stems, hand broadcast Spike 20P evenly beneath the woody plant canopy at a rate of 1/4 oz per 22 square feet.

Broadcast Application

Spike 20P must be applied with ground or aerial application equipment capable of accurate calibration and able to provide a uniform distribution of pellets on the soil surface. Use of application equipment not capable of confining the spread of pellets to the target area may result in injury or death of desirable vegetation outside the intended treatment area. Contact an Elanco Specialty Sales Representative for recommendations on application equipment for different use situations.

Spike 20P may be applied by ground or air broadcast by/or under the supervision of U.S. Government Agencies.

Broadcast Application Rates

Pasture and Rangeland: Apply Spike 20P at application rates of 3-3/4 to a maximum of 20 lb/Acre.

Noncrop Areas Such as Railroad and Utility Rights-of-Way, Wildlife Openings, Industrial Sites, Pipelines, Fence Rows, Firebreaks, Ditchbanks and along Highways: Apply Spike 20P at 3-3/4 to a maximum of 30 lb/Acre.

See methods of application and rate recommendations for species listed below.

Spike 20P at 3-3/4 to 5-lb/Acre: (Pastureland, Rangeland and Noncropland)

Burroweed (Density less than 1/sq. ft.)	*Haplopappus tenuisectus*
Ceniza	*Leucophyllum frutescens*
Creosotebush	*Larrea tridentata*
Mimosa, Catclaw (Wait-a-minute-bush)	*Mimosa pigra*
Paloverde	*Cercidium spp.*
Sagebrush, Big (Partial control)	*Artemisia tridentata*
Sagebrush, Sand (Partial control)	*Artemisia filifolia*
Snakeweed, Broom (Density less than 1/sq. ft.)	*Gutierrezia sarothrae*
Tarbush	*Flourensia cernua*
Whitethorn	*Acacia constricta*

Spike 20P at 3-3/4 to 7-1/2 lb/Acre: (Pastureland, Rangeland and Noncropland)

Oak, Sand Shinnery* (Partial control)	*Quercus havardii*

*Note: Use higher rates in rate range for these sands and shinnery varieties with dense growth habit.

Spike 20P at 5 to 10 lb/Acre: (Pastureland, Rangeland and Noncropland)

Oak, Bigelow* (Partial control)	*Quercus durandi*
Oak, Mohr* (Partial control)	*Quercus mohriana*
Oak, Running Live* (Partial control)	*Quercus virginiana*
Whitebrush	*Aloysia lycioides*
Wolfberry, Berlandieri	*Lycium berlandieri*

*Use higher dose in rate range on tall dense stands.

Spike 20P at 10 to 20 lb/Acre: (Pastureland, Rangeland and Noncropland)

Acacia, Blackbrush	*Acacia rigidula*
Acacia, Catclaw	*Acacia greggii*
Acacia, Twisted	*Acacia tortuosa*
Alder, Speckled*	*Alnus rugosa*
Birch, Gray*	*Betula populifolia*
Blueberry	*Vaccinium spp.*
Bluewood (Brazil)	*Condalia obovata*
Buckbrush	*Symphoricarpos orbiculatus*
Cherry, Bitter	*Prunus emarginata*
Cottonwood, Eastern*	*Populus deltoides*
Dogwood, Roughleaf	*Cornus drummondi*
Elm, American	*Ulmus americana*
Elm, Winged	*Ulmus alata*
Fir, Balsam*	*Abies balsamea*
Guajillo	*Acacia berlandieri*
Hackberry, Spiney (Granjeno)	*Celtis pallida*
Hackberry, Western	*Celtis occidentalis*
Hardhack*	*Spiraea tomentosa*
Hawthorn	*Crataegus spp.*
Huckleberry	*Gaylussacia spp.*
Huisache*	*Acacia farnesiana*
Locust, Black	*Robinia pseudoacacia*
Manzanita	*Arctostaphylos spp.*
Maple, Sugar*	*Acer saccharum*
Mulberry, Red	*Morus rubra*
Oak, Black	*Quercus velutina*
Oak, Blackjack	*Quercus marilandica*
Oak, Blue	*Quercus douglasii*
Oak, Bur	*Quercus macrocarpa*
Oak, Post	*Quercus stellata*
Oak, Shrub live	*Quercus turbinella*
Oak, Southern red	*Quercus falcata*
Oak, White	*Quercus alba*
Pine*	*Pinus spp.*
Poplar, Balsam*	*Populus balsamifera*
Rose, McCartney*	*Rosa bracteata*
Rose, Multiflora	*Rosa multiflora*
Sage, Black	*Salvia mellifera*
Spruce, White*	*Picea glauca*
Sumac, Dwarf	*Rhus copallina*
Sumac, Littleleaf	*Rhus microphylla*
Sumac, Skunkbush	*Rhus trilobata*
Sumac, Smooth	*Rhus glabra*
Sumac, Staghorn	*Rhus typhina*
Tamarack*	*Larix laricina*
Thornapple, Desert	*Datura discolor*
Yaupon	*Ilex vomitoria*
Yaupon, Desert	*Schaefferia cuneifolia*

*Use higher dosage in indicated rate range on all sites.

Spike 20P at 20 to 30 lb/Acre: (Noncropland Use Only)

Alder, Red	*Alnus rubra*
Ash, Green*	*Fraxinus pennsylvanica*
Aspen, Bigtooth	*Populus grandidentata*
Beech, American	*Fagus grandifolia*
Blackberry	*Rubus spp.*
Blackberry, Cutleaf*	*Rubus laciniatus*
Boxelder	*Acer negundo*
Chamise	*Adenostoma fasciculatum*
Cherry, Black*	*Prunus serotina*
Cholacherry, Common	*Prunus virginiana*
Colubrina, Texas	*Colubrina texensis*
Coyotebrush*	*Baccharis pilularis*
Creeper, Virginia	*Parthenocissus quinquefolia*
Dogwood, Flowering	*Cornus florida*
Douglasfir	*Pseudotsuga menziesii*
Gueyacan	*Porlieria angustifolia*
Hickory, Bitternut	*Carya cordiformis*
Hickory, Black	*Carya texana*
Hickory, Pignut	*Carya glabra*
Hickory, Shagbark	*Carya ovata*
Huisache	*Acacia farnesiana*
Kidneywood, Texas	*Eysenhardtia texana*
Kudzu	*Pueraria lobata*
Lantana*	*Lantana camara*
Leatherstem	*Jatropha dioica*
Lotebush (Condalia)	*Ziziphus obtusifolia*
Maple, Bigleaf	*Acer macrophyllum*
Maple, Norway*	*Acer platanoides*
Maple, Silver*	*Acer saccharinum*
Melaleuca*	*Melaleuca quinquenervia*
Mountainmahogany, Birchleaf	*Cercocarpus betuloides*
Oak, California Scrub	*Quercus dumosa*
Oak, Live	*Quercus virginiana*
Oak, Pin	*Quercus palustris*
Oak, Red	*Quercus rubra*
Oak, White	*Quercus alba*
Peppertree, Brazilian*	*Schinus terebinthifolius*
Pine	*Pinus spp.*
Raspberry, Black*	*Rubus occidentalis*
Salal*	*Gaultheria shallon*
Sweetgum	*Liquidambar styraciflua*
Sycamore, American*	*Platanus occidentalis*
Trumpetcreeper	*Campsis radicans*
Tuliptree*	*Liriodendron tulipifera*
Willow	*Salix spp.*

*Use higher dosage in indicated rate range on all sites.

Spike 20P at 30 lb/Acre: (Noncropland Use Only)

Ash, White	*Fraxinus americana*
Ceanothus, Wedgeleaf	*Ceanothus cuneatus*
Chaparral, Whitethorn	*Ceanothus leucodermis*
Elm, Chinese	*Ulmus parvifolia*
Elm, Slippery	*Ulmus rubra*
Greenbrier, Roundleaf	*Smilax rotundifolia*
Hawthorn, Cockspur	*Crataegus crus-galli*
Manzanita, Greenleaf	*Arctostaphylos patula*
Maple, Vine	*Acer circinatum*
Privet	*Ligustrum spp.*
Redcedar, Eastern	*Juniperus virginiana*
Russianolive	*Elaeagnus angustifolia*
Sumac, Laurel	*Rhus laurina*
Tallowtree, Chinese	*Sapium sebiferum*

Precaution: Spike 20P will kill trees and shrubs. Carefully read the precautions before using.

Do not use Spike 20P in any area where desirable species are in the vicinity of the plants to be controlled. A small amount of Spike in contact with the roots of desirable trees or other woody species may cause severe injury or death. The roots of such plants may extend far beyond their drip lines.

Spike 20P will injure or control other herbaceous vegetation in the treated area. Therefore, do not apply where such injury cannot be tolerated.

Disclaimer of Warranties

Elanco Products Company makes no warranties concerning this product or its use, which extend beyond the description on the label. All other warranties, expressed or implied, including but not limited to, any implied warranties of merchantability and fitness for a particular purpose, are disclaimed. All statements concerning this product apply only when used as directed. This disclaimer of warranties does not apply where prohibited by operation of law.

Limitation of Damages

The liability of Elanco Products Company, whether in contract, warranty, tort, negligence, strict liability or otherwise, shall not exceed the return of the amount of the purchase price of this product and under no circumstances shall Elanco be liable for special, indirect or consequential damages. This limitation of damages does not apply where prohibited by operation of law.

Inherent Risks of Use

Plant injury, unsatisfactory brush or woody plant control or other unintended consequences may result from such factors as weather conditions, presence of other materials or application of Spike 20P contrary to label instructions, all of which are beyond the control of Elanco.
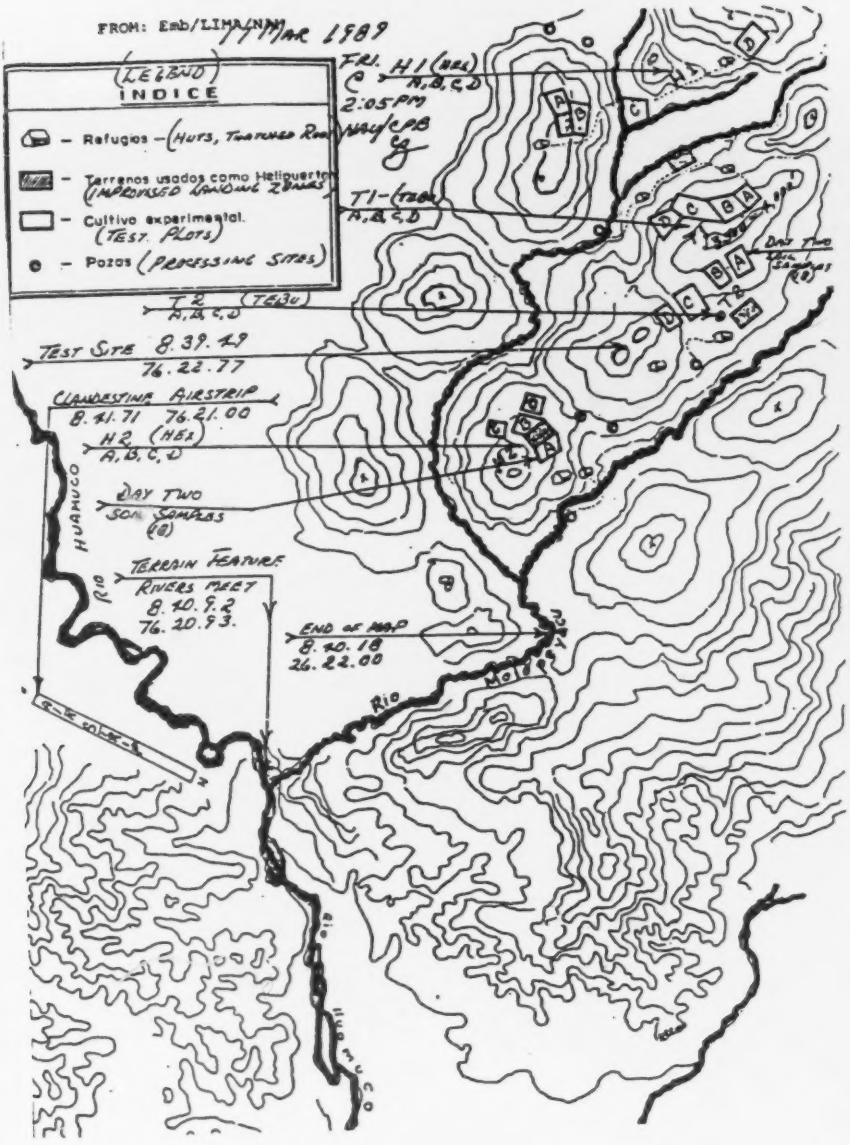
FIGURE 1. Map of the Study Area and Targeted Fields
To Receive Tebuthiuron (T) of Hexazinone (H)
at Either 1.1 (1) or 2.2 (2) kg/ha